

# BRL



CONTRACT 169

REPORT NO. 6

AD662719

UPPER ATMOSPHERE WINDS FROM  
GUN LAUNCHED VERTICAL PROBES  
(Yuma, 16-19 November 1966)

SPACE INSTRUMENTS RESEARCH, INC.

BRL CONTRACT 169      REPORT 6

UPPER ATMOSPHERE WINDS FROM  
GUN LAUNCHED VERTICAL PROBES  
(Yuma, 16-19 November 1966)

Prepared for

U. S. Army  
Ballistic Research Laboratories  
Aberdeen Proving Ground, Maryland

Contract No. DA-01-009-AMC-169(X)

Prepared by:

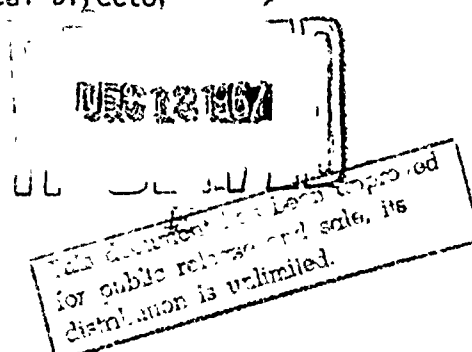
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SPACE INSTRUMENTS RESEARCH, INC.  
Atlanta, Georgia

June 1967

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### WIND PROFILES:

Fifteen Trail Releases	November 16-19, 1966	16
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NOTE: The wind vector as given in this report is considered to point in the direction toward which the wind is blowing, (that is, a west wind is toward the west). Most meteorologists are accustomed to a 180° difference (that is, a west wind is from the west.)

## INTRODUCTION

For several years upper atmospheric winds over the lower West Indies have been studied by firing high altitude ballistic probes from a sixteen-inch gun. The installation of a similar 16" gun at Yuma Proving Ground, Arizona, early in 1966 has made possible a similar study of winds in this region. These firings are being carried out by the U. S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, under the direction of Dr. Charles P. Murphy, and by the Space Research Institute of McGill University, Canada, under the direction of Dr. G. V. Bull.

Atmospheric winds are studied by releasing chemical trails from the gun-fired probes during the upper portion of their trajectories. To date, the primary chemical which has been released is trimethyl aluminum (TMA). TMA produces a chemiluminescent glow in regions of the atmosphere above 85 kilometers, thus allowing the trails to be photographed while being distorted by upper atmosphere winds. The photographs are then reduced to provide wind information by Space Instruments Research, Inc. (SIR), using computer techniques.

The purpose of this report is to summarize results of these studies for the period from November 16 through November 19, 1966. A "Table of Trail Information" is given on page 15 and lists the trail number, shot number, date, time and altitude interval. Previous results for winds over Barbados, West Indies, are covered in Technical Reports No. 1, 2, 3, and 5. Technical report No. 4 covers previous results for winds over Yuma, Arizona.

## DATA ACQUISITION

The chemical trails are formed almost vertically over the gunsite (longitude 114.3°W. latitude 32.9°N) and extend from an altitude of approximately 85 kilometers through apogee. In some firings, TMA is also released on the down leg of the trajectory. To the unaided eye, the chemical release first appears as a straight white trail resembling a jet contrail. Within a minute or so, the trail is distorted into strange shapes by the upper atmospheric winds (see Figure 1) and fades from view within approximately fifteen minutes after initial release.

Space Instruments Research has established three photographic triangulation stations at Yuma and Pila Bend, Arizona, and Blythe, California. These sites are located at distances of up to 150 kilometers from the gunsite (see Figure 2).

Equipment at each site, built by SIR, consists of a camera unit containing two seven-inch focal length cameras mounted on a concrete pedestal, and an electronic control unit. Cameras are automatically pulsed to take exposures of 3, 6, and 12 seconds duration every 30 seconds.

Since commercial power is either unreliable or unavailable at many site locations, SIR has developed a battery operated 115-volt power supply for the control equipment. The power supply is tuning-fork controlled and provides 60 cycle power with an accuracy of 0.005% for the camera programmer so that pictures can be taken simultaneously at each site. A data block containing 24 tiny lights, mounted in each camera unit, records time, firing number, and site information in the corner of each frame of film.

During a typical night's operation, the gun is fired at one to two hour intervals, from sunset to sunrise. Photographs are taken by all sites during the time that the trail is visible. The film is then returned to Atlanta for processing and data reduction.

## DATA REDUCTION

Several computer programs have been developed which make it possible to calculate upper atmosphere winds from measurements made directly on the photographs of the luminous trails.

Since the method used is basically three-dimensional triangulation using spherical trigonometry, it is necessary to know precisely the direction each camera was pointed during a given firing. The direction is determined by first taking accurate measurements of the locations of several star images on the film, and then computing the azimuth and elevation of the optical axis of the camera by means of a computer program. This computer program makes use of the celestial coordinates of some 6,000 stars which have been stored on magnetic tape.

Wind speeds and directions are then determined from the location of the trail in space at a succession of known times. The location is found, using either a point location program or a trail location program, or both, and depends on the physical shape of the chemical release cloud.

Point location method. If the chemical release exhibits discrete points (resulting either from turbulence or from the nature of the release mechanism) and these points can be identified on films from two or more sites, the point location program can be used to calculate the position of each point in longitude, latitude, and altitude above sea level.

These calculations are made from data taken at successive times. A wind program is then used to calculate both vertical and horizontal winds from the motion of these points as a function of time.

Trail location method. Most of the chemical releases produce a smooth trail having few, if any, identifiable points. In such cases, film coordinates of a large number of incremental points along the film image of the trail are fed into the computer from data from two or more sites. The trail location program attempts to triangulate each point from one site with many points from another site, finally choosing points from both sites whose optical paths from camera into space form the closest spatial intersection. After doing many hundreds of such calculations, the computer is able to construct coordinates for a mathematical curve in the shape of the trail in space. Then, as with the point location program, winds can be determined from the motion of the curve with time. Here, however, it must be assumed that vertical winds are essentially zero. This assumption is borne out by previous studies which have shown vertical winds in this altitude region to be of the order of a few meters per second compared to horizontal winds ranging up to 150 meters per second.

Corrections for variables such as atmospheric refraction, rotation of camera about optical axis, and camera focal length, are incorporated into the programs to maintain high accuracy. Focal length and camera rotation are, in fact, calculated from measurements of the positions of star images on the films.



## INTERPRETATION OF DATA

Following the "Table of Trail Information," horizontal wind velocities are presented in tabular form and in plots of wind speed, direction, and components.

Winds were calculated at altitude intervals of one kilometer. Points on the various plots show the actual computed result, as listed in the table preceding the plot. A curve has been fitted to each set of points to aid in detecting wind patterns and to indicate reliability of the plotted results. Each curve has been drawn with a knowledge of intermediate results leading to the wind calculations and of the consistency of the winds as calculated between each of the five or more time intervals used. In cases where point-to-point curve fitting was not thought to reflect actual variations in wind speed, direction, or components, a more appropriate smooth curve has been drawn. Otherwise, the curves are fitted directly to the data points. Results of certain portions of the trails are at times less accurate than others due to the spatial orientation of those trail segments relative to the available photographic stations. Less accurate data also can result from photographs obscured by haze and clouds and from trails of short duration.

Wind speed plot. This plot shows the speed of the wind in meters per second as a function of height in kilometers above sea level.

Wind direction plot. The wind vector is considered to point in the direction toward which the wind is moving. The direction plot shows the direction of this vector in degrees clockwise from north as seen from above. Thus, a wind direction toward the east would be 90 degrees.

Wind components plot. While plots of wind direction and speed do completely describe the wind vector, it has been found helpful in studying wind patterns to present the north-south (N-S) and east-west (E-W) velocity components of the vector. In the north-south plot, north is positive; south is negative. In the east-west plot, east is positive, west negative. Components are plotted in meters per second versus height in kilometers.

The wind direction and components described above are referenced to true north. In addition, components have been calculated relative to magnetic north for comparison with other ionospheric phenomena. These components are not plotted but are listed in the tabulations preceding each set of plots.

Throughout this report, where shorter notation was desirable, "Up" or "U" and "Down" or "D" have replaced uptrail and downtrail, respectively.

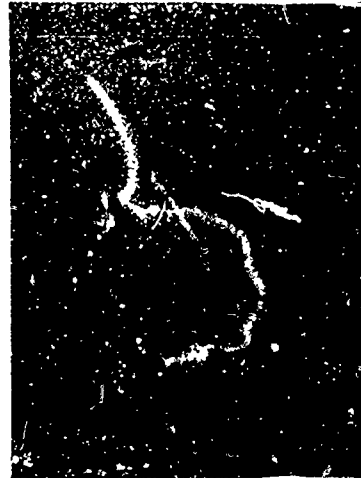
FIGURE 1

PHOTOGRAPHS OF SHOT TWENTY-SIX

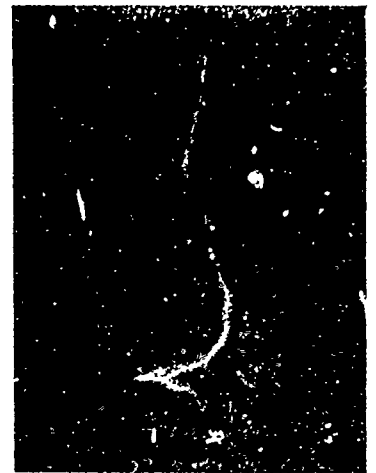
Photographs taken 132 seconds after firing:



YUMA



BLYTHE



GILA BEND

This set of pictures shows trail just as the vehicle stopped releasing chemical. Numbers indicate altitude in kilometers.

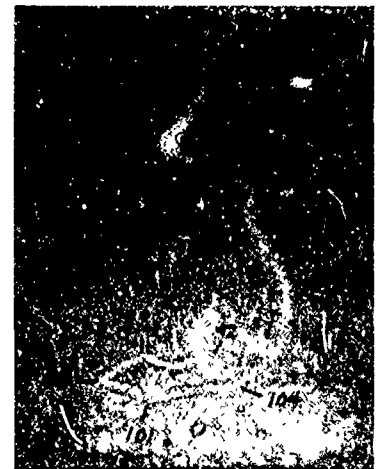
Photographs taken 202 seconds after firing:



YUMA



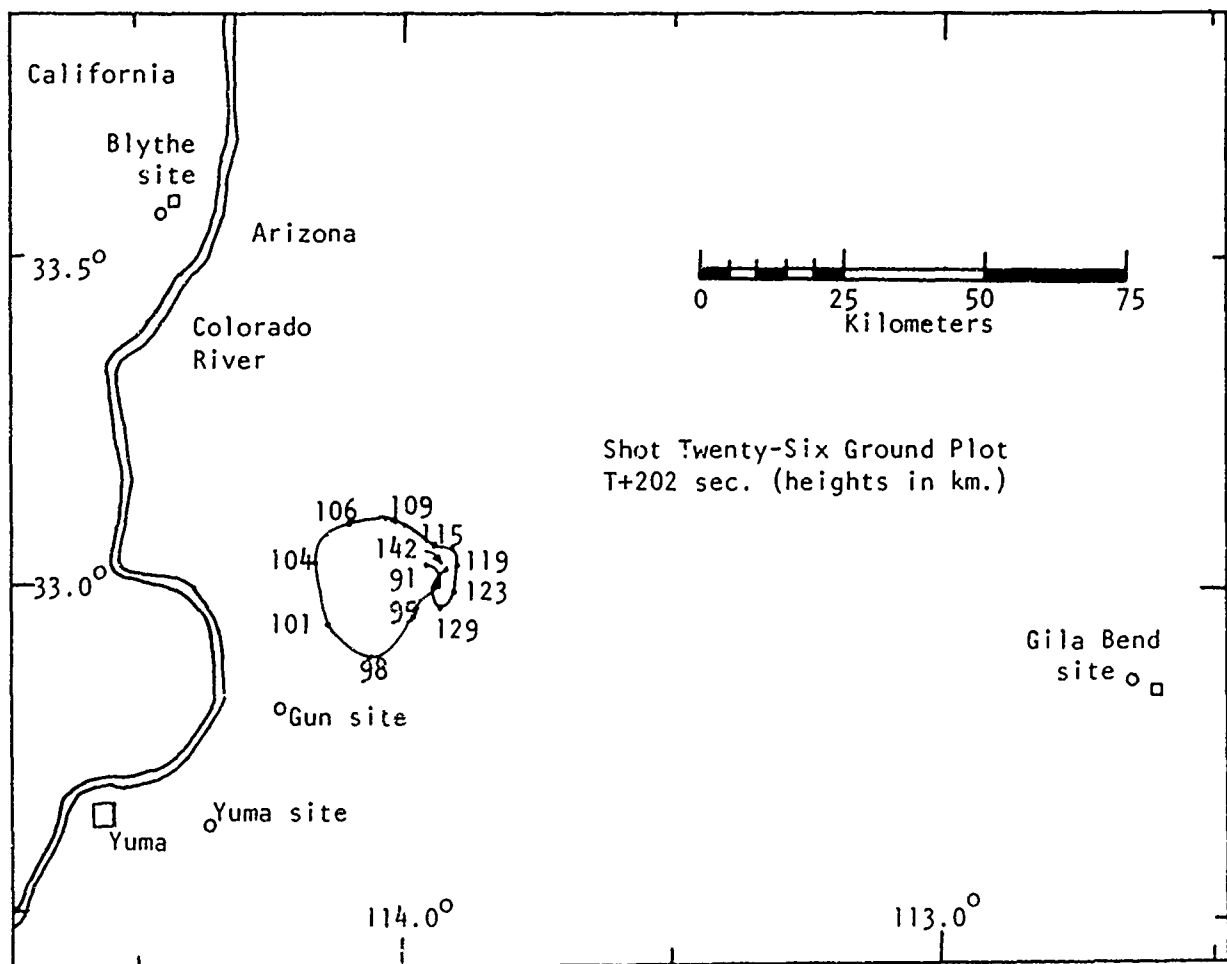
BLYTHE



GILA BEND

These pictures show trail corresponding to ground plot on next page.

Figure 2  
 Location of SIR Photographic Stations  
 HARP - Yuma



## SYNOPSIS OF RESULTS

The following comments may be helpful in interpreting the data contained in this report. Only those trails with unusual characteristics are discussed.

Trails No. Y12, Y13, Y22, and Y23 gave unusually high wind speeds which were generally in an eastward direction. On all four trails these high wind speeds occurred primarily in an altitude region from 104 to 112 kilometers.

### Trail No. Y13

Results at several altitudes of the uptrail were unobtainable because of insufficient data. The downtrail, however, did provide results at some of these altitudes, and the curve was consequently drawn through plotted results. For altitudes where neither uptrail nor downtrail provided results, a dashed curve was drawn in a smooth fashion. Separate curves were drawn at altitudes where confirmed differences in uptrail and downtrail exist.

These differences in uptrail and downtrail results are primarily in wind speed. The wind direction at some of the altitudes where speed differences occur is the same.

### Trail No. Y15

Uptrail and downtrail winds were distinctly different at practically all altitudes for which both up and down results were obtained.

### Trail No. Y20

The apogee for this shot (No. 28) was quite high, being approximately 180 km. However, since the chemical was spread over such a long range,

the visible trail faded very rapidly, particularly at the high altitudes. Therefore, only wind data up to 167 km was obtainable.

Trail No. Y22

The wind results of the uptrail and downtrail again differed distinctly at some altitudes. The magnitude of difference becomes larger with increasing altitude.

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TABLE OF TRAIL INFORMATION

<u>Trail No.</u>	<u>Shot No.</u>	<u>Date</u>	<u>Time (MST)</u>	<u>Altitudes (km)</u>
Y10	0017	16 November 1966	18:41:24	92-112
Y11	0018	16 November 1966	20:41:52	90-119
Y12	0019	16 November 1966	22:32:07	90-112
Y13	0020	17 November 1966	00:16:13	96-120
Y14	0022	18 November 1966	18:18:47	88-120
Y15	0023	18 November 1966	20:12:21	85-127
Y16	0024	18 November 1966	21:49:42	89-139
Y17	0025	18 November 1966	23:43:00	89-138
Y18	0026	19 November 1966	01:01:22	91-144
Y19	0027	19 November 1966	02:35:35	88-120
Y20	0028	19 November 1966	04:52:53	92-167
Y21	0030	19 November 1966	19:45:00	93-142
Y22	0031	19 November 1966	21:21:29	91-111
Y23	0032	19 November 1966	22:37:53	90-111
Y24	0033	19 November 1966	23:59:14	91-147

TTTTTTTT

100

1

YUMA

TRAIL NO. Y10  
16 NOVEMBER 1966

18-41-24 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
92.0	318.7	39.7	29.8	-26.2	22.4	-32.7
93.0	321.1	41.5	32.3	-26.0	24.9	-33.2
94.0	327.9	42.5	36.0	-22.6	29.3	-30.8
95.0	7.2	53.5	53.1	6.7	53.1	-6.6
96.0	20.3	56.9	53.4	19.8	56.6	6.0
97.0	28.7	51.1	44.8	24.5	49.5	12.7
98.0	43.9	40.3	29.0	27.9	35.0	19.9
99.0	78.7	30.7	6.0	30.1	13.2	27.7
100.0	108.0	32.2	-9.9	30.6	-2.1	32.1
101.0	119.9	34.8	-17.4	30.2	-9.4	33.6
102.0	116.8	29.6	-13.3	26.4	-6.4	28.9
103.0	106.1	20.6	-5.7	19.8	-0.7	20.6
104.0	62.8	15.4	7.0	13.7	10.2	11.6
105.0	40.9	22.5	17.0	14.7	20.1	10.1
106.0	29.7	19.1	16.6	9.5	18.4	5.1
107.0	208.0	24.7	-21.8	-11.6	-24.0	-5.9
108.0	220.8	68.0	-51.5	-44.4	-60.8	-30.4
109.0	220.2	87.2	-66.6	-56.2	-78.4	-38.1
110.0	219.6	110.4	-85.0	-70.5	-99.7	-47.4
111.0	224.4	118.7	-84.9	-83.1	-102.7	-59.6
112.0	231.2	123.5	-77.3	-96.3	-98.6	-74.3

WIND COMPONENTS

UP

N-S ○

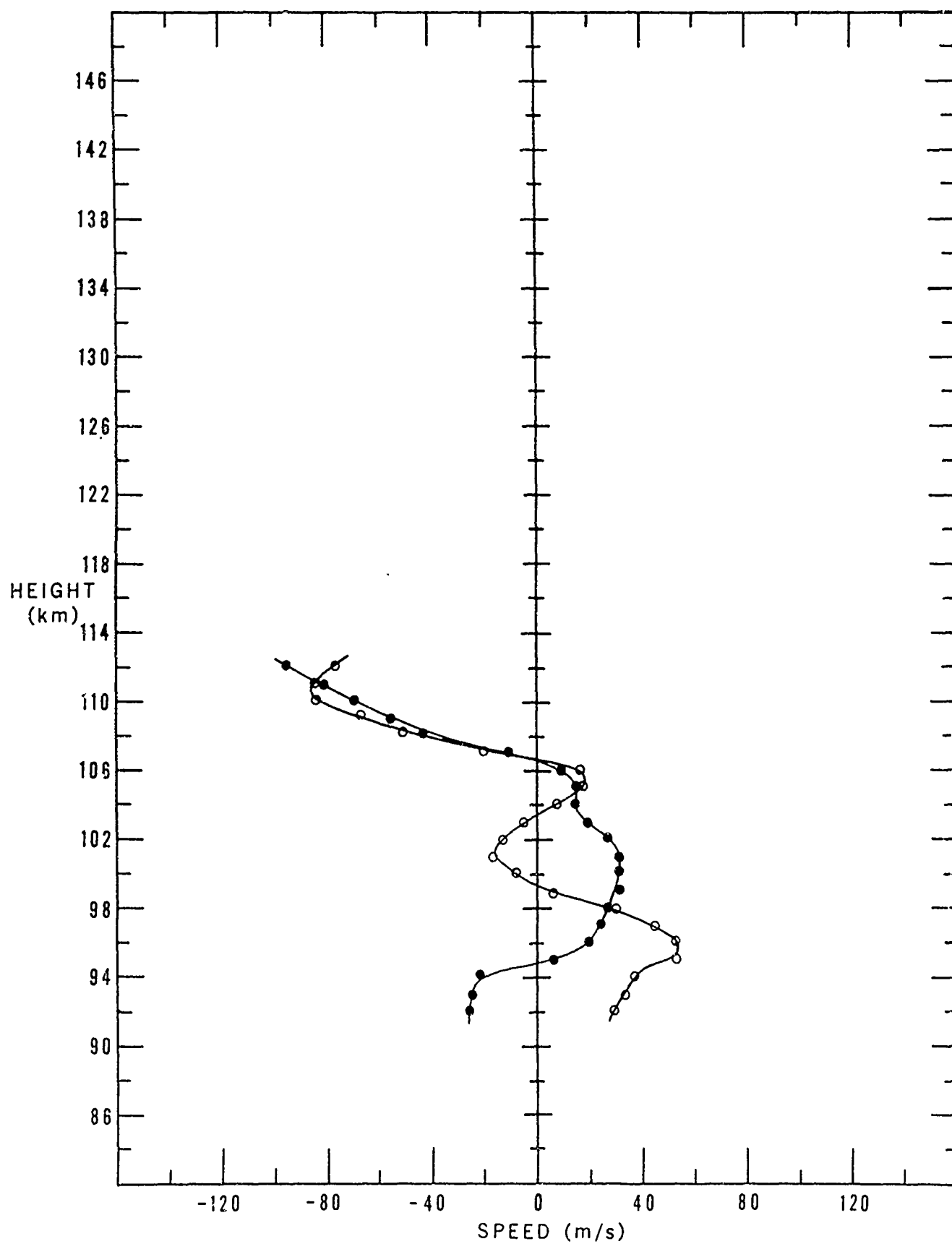
E-W ●

TRAIL NO. Y10

18:41:24 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

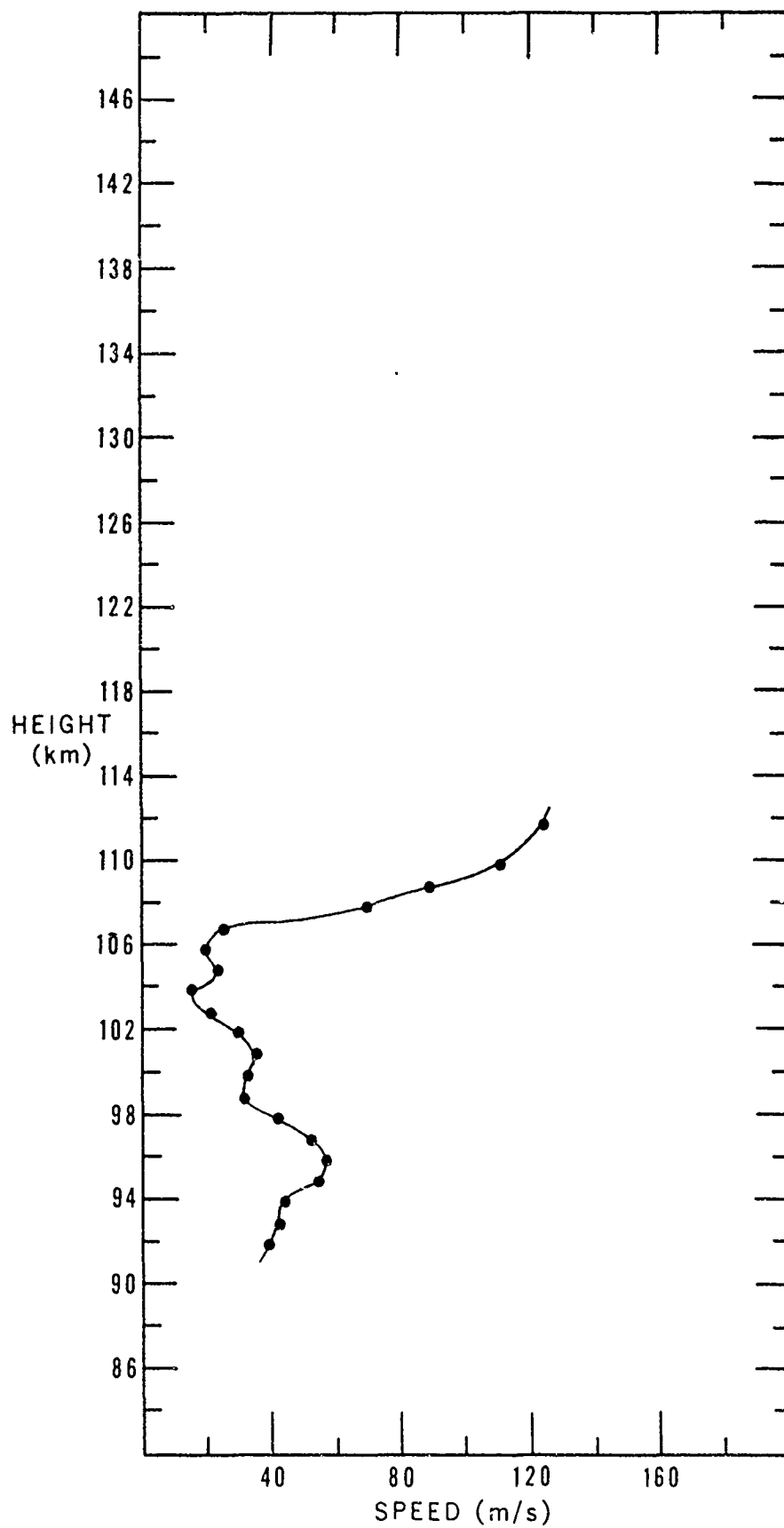
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TRAIL NO. Y10

18:41:24 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

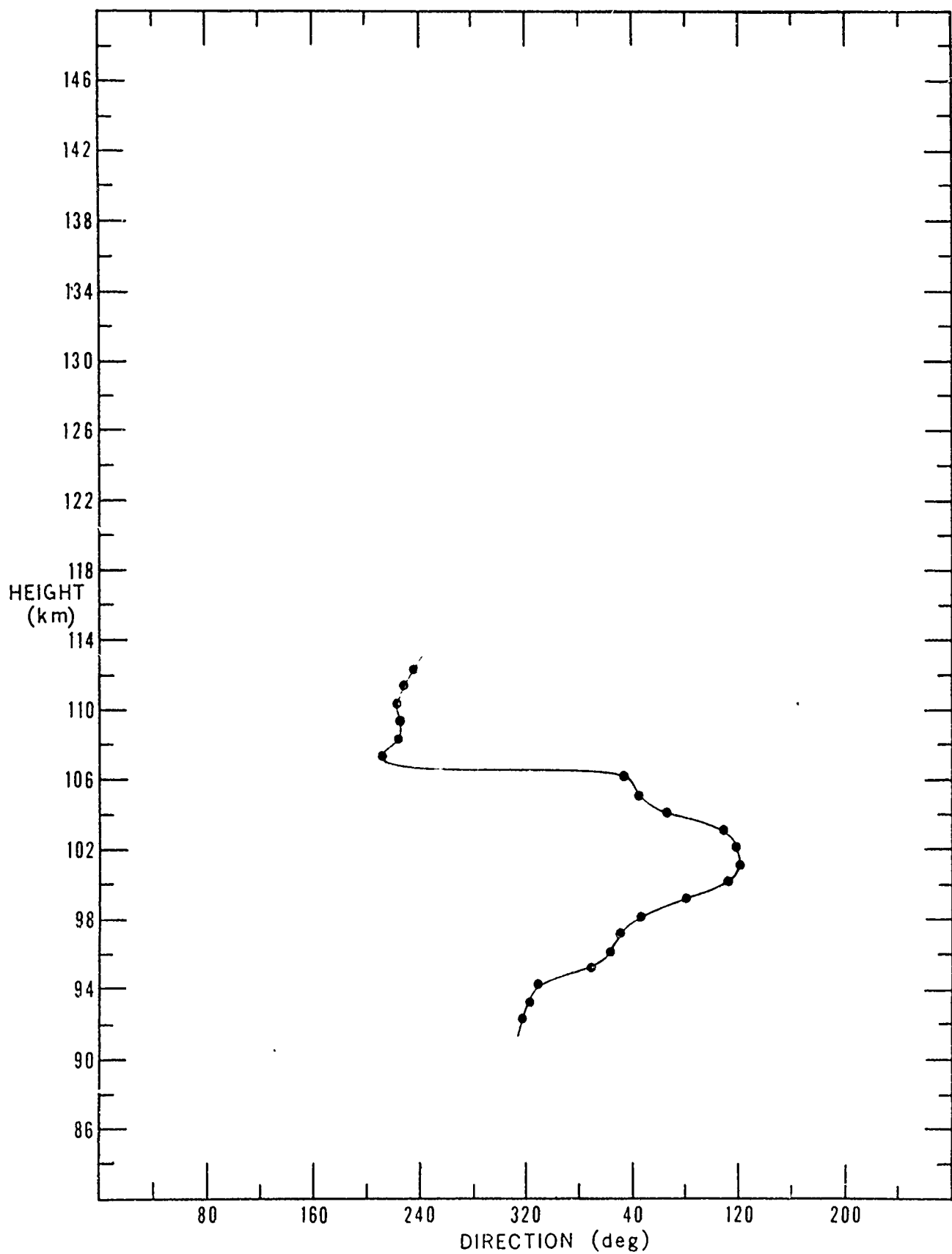
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TRAIL NO. Y10

18:41:24 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y11  
16 NOVEMBER 1966

20-41-52 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
90.0	54.0	5.7	3.4	4.6	4.4	3.6
91.0	340.7	4.7	4.5	-1.6	4.0	-2.7
92.0	9.0	5.6	5.6	0.9	5.6	-0.5
93.0	46.3	10.7	7.4	7.7	9.1	5.6
94.0	78.4	21.6	4.4	21.2	9.5	19.5
95.0	88.0	32.0	1.1	32.0	8.9	30.7
96.0	79.7	37.7	6.8	37.1	15.7	34.3
97.0	78.6	43.2	8.5	42.3	18.7	38.9
98.0	81.2	50.6	7.8	50.0	19.9	46.5
99.0	95.5	71.8	-6.9	71.5	10.9	71.0
100.0	102.5	74.9	-16.2	73.1	2.3	74.8
101.0	105.5	64.3	-17.2	62.0	-1.4	64.3
102.0	126.7	21.3	-12.7	17.1	-8.1	19.7
103.0	215.3	71.3	-58.2	-41.2	-66.6	-25.6
104.0	212.9	110.2	-92.5	-59.9	-104.4	-35.3
105.0	211.5	125.4	-106.9	-65.6	-119.8	-37.3
106.0	213.7	133.6	-111.1	-74.1	-125.9	-44.5
107.0	226.6	135.3	-93.0	-98.2	-114.3	-72.3
108.0	233.3	136.3	-81.5	-109.3	-105.9	-85.9
109.0	255.6	133.0	-33.0	-128.8	-63.7	-116.7
110.0	261.1	138.8	-21.4	-137.1	-54.5	-127.6
111.0	269.7	145.5	-0.7	-145.5	-36.5	-140.9
112.0	284.5	161.3	40.3	-156.2	0.6	-161.3
113.0	288.5	157.3	49.8	-149.2	11.5	-156.9
114.0	291.8	155.8	58.0	-144.6	20.6	-154.4
115.0	301.6	140.0	73.3	-119.2	41.7	-133.6
116.0	305.3	135.8	78.5	-110.8	48.8	-126.7
117.0	307.3	135.0	81.8	-107.4	52.8	-124.2
118.0	309.5	132.1	83.9	-102.0	56.2	-119.5
119.0	317.6	100.8	74.5	-67.9	55.5	-84.1



# WIND COMPONENTS

UP

N-S ○

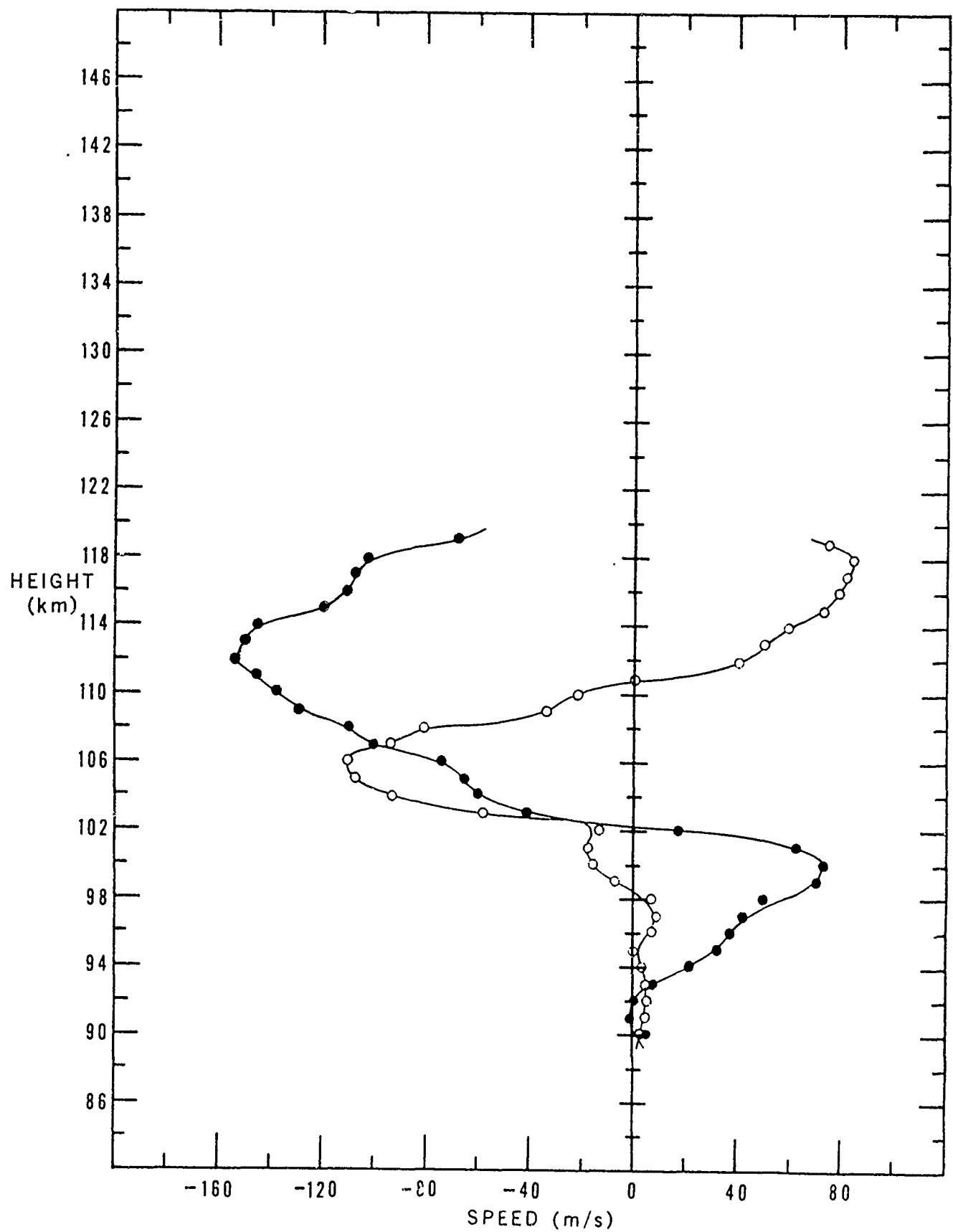
E-W ●

TRAIL NO. Y11

20:41:52 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

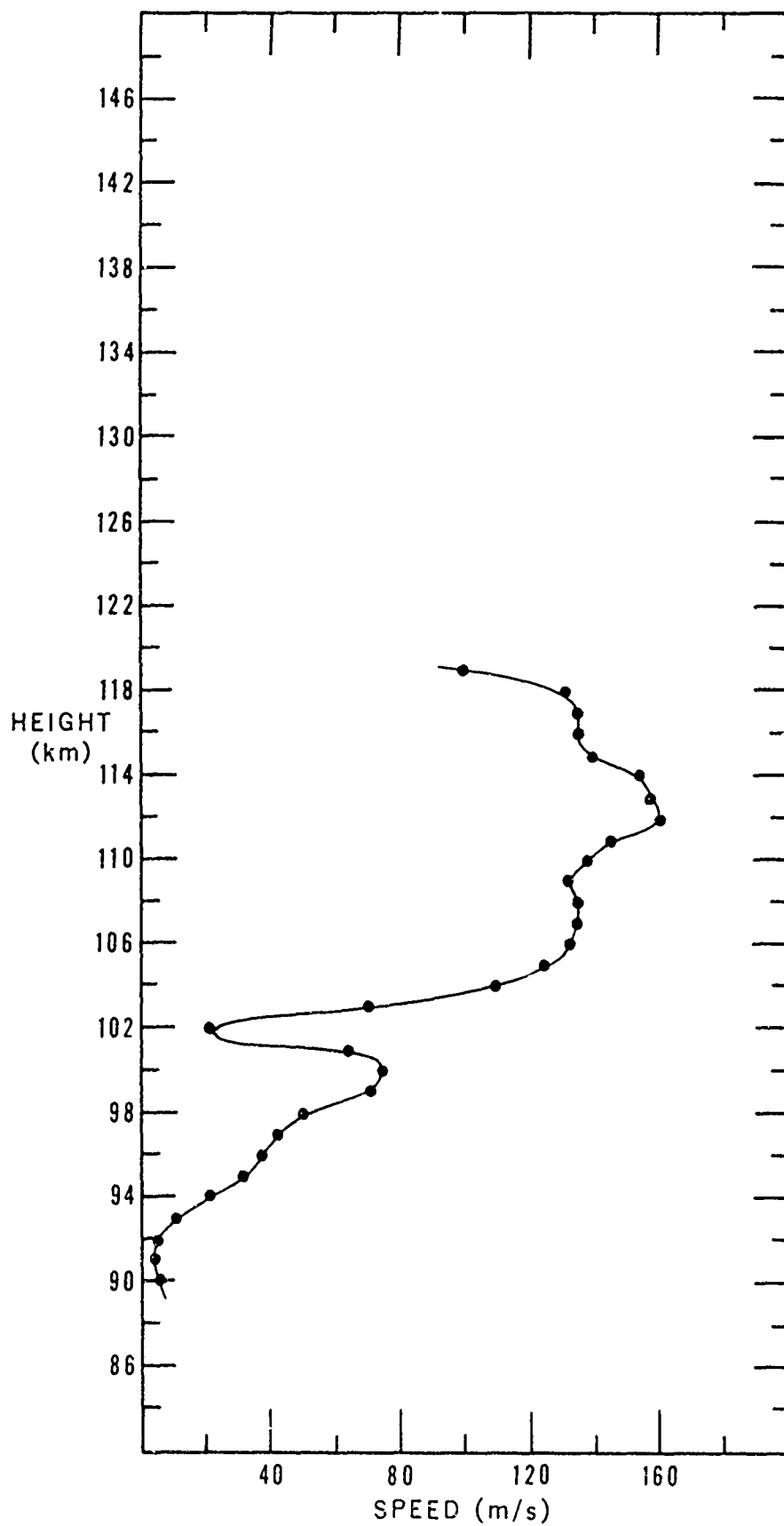
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TRAIL NO. Y11

20:41:52 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

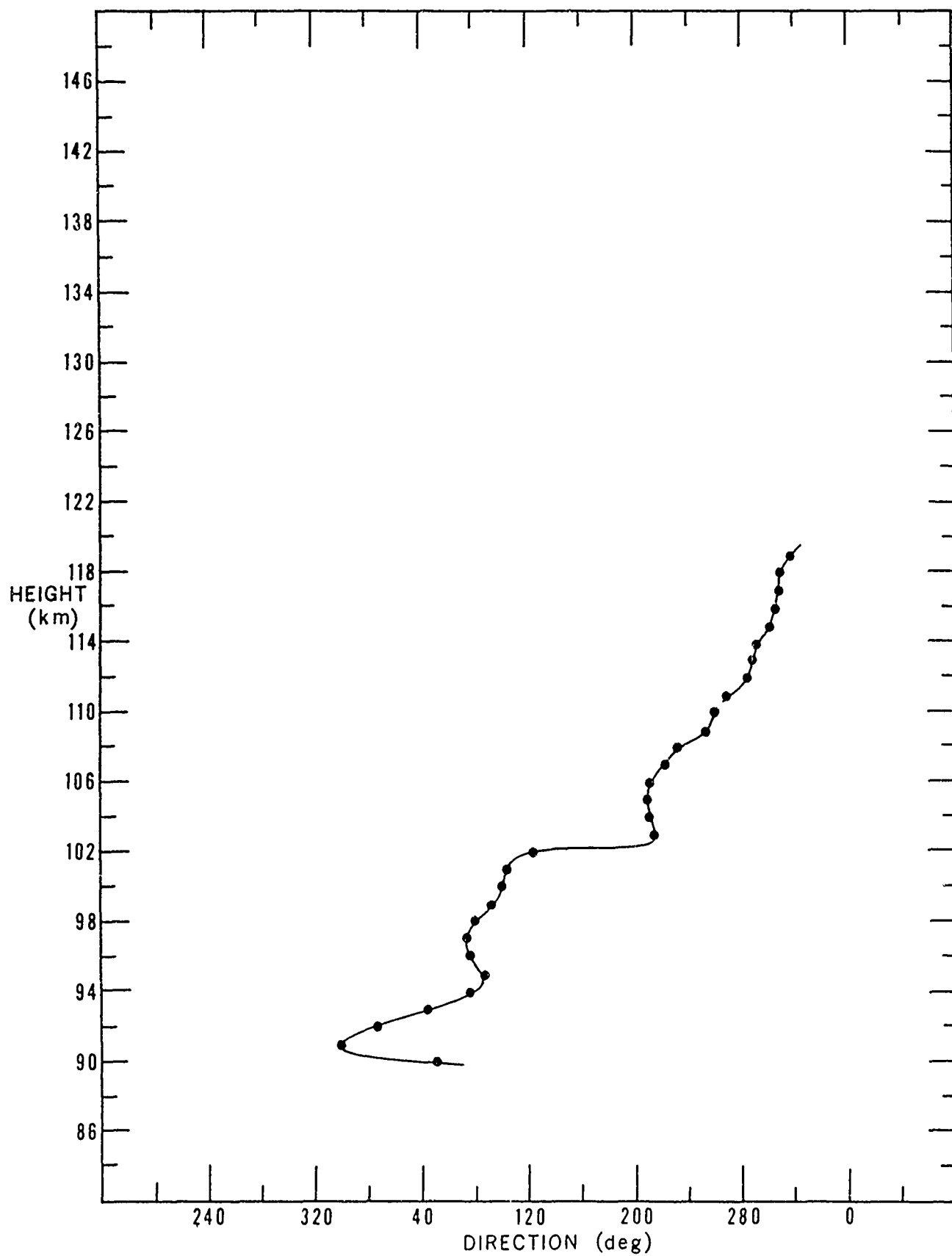
• UP

TRAIL NO. Y11

20:41:52 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y12  
16 NOVEMBER 1966

22-3. -07 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC		MAGNETIC	
			WIND COMPONENTS (M/S)			
			N-S	E-W	N-S	E-W
90.0	132.5	14.4	-9.8	10.7	-6.9	12.8
91.0	114.6	15.2	-5.5	12.0	-2.4	13.0
92.0	90.9	12.5	-0.2	12.5	2.9	12.2
93.0	87.6	37.6	1.6	37.6	10.8	36.0
94.0	96.8	39.0	-4.6	38.7	5.1	38.6
95.0	97.5	45.4	-5.9	45.0	5.4	45.1
96.0	97.5	59.3	-7.7	58.8	7.0	58.9
97.0	92.9	64.7	-3.3	64.6	12.7	63.4
98.0	104.3	61.9	-15.3	60.0	-0.1	61.9
99.0	157.6	47.0	-43.5	17.9	-37.8	28.1
100.0	185.8	71.5	-71.1	-7.3	-70.7	10.4
101.0	202.0	76.3	-70.7	-28.6	-75.6	-10.3
102.0	216.4	84.9	-68.3	-50.3	-78.6	-31.9
103.0	234.6	118.5	-68.7	-96.6	-90.4	-76.7
104.0	242.8	126.9	-58.0	-112.8	-84.0	-95.1
105.0	254.3	149.7	-40.4	-144.2	-74.7	-129.8
106.0	262.5	153.0	-20.0	-151.6	-56.7	-142.0
107.0	268.6	169.1	-4.2	-169.1	-45.7	-162.9
108.0	284.1	173.5	42.3	-168.2	-0.4	-173.4
109.0	293.7	181.3	72.9	-165.9	29.8	-178.7
110.0	310.6	132.8	86.4	-100.8	58.9	-119.0
111.0	311.0	128.4	84.3	-96.8	57.9	-114.6
112.0	315.8	118.3	84.8	-82.5	61.9	-100.8

# WIND COMPONENTS

UP

N-S ○

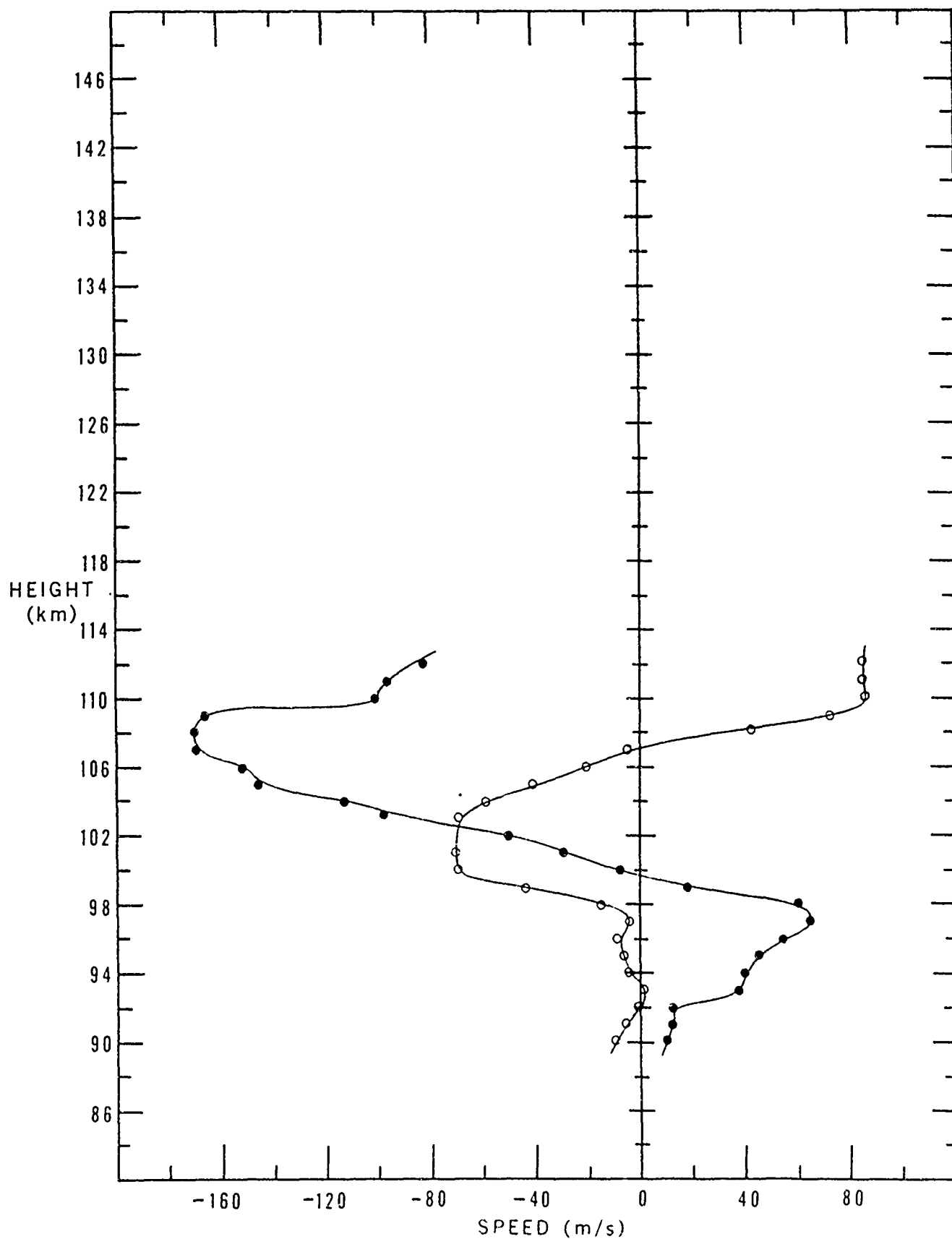
E-W ●

TRAIL NO. Y12

22:32:07 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

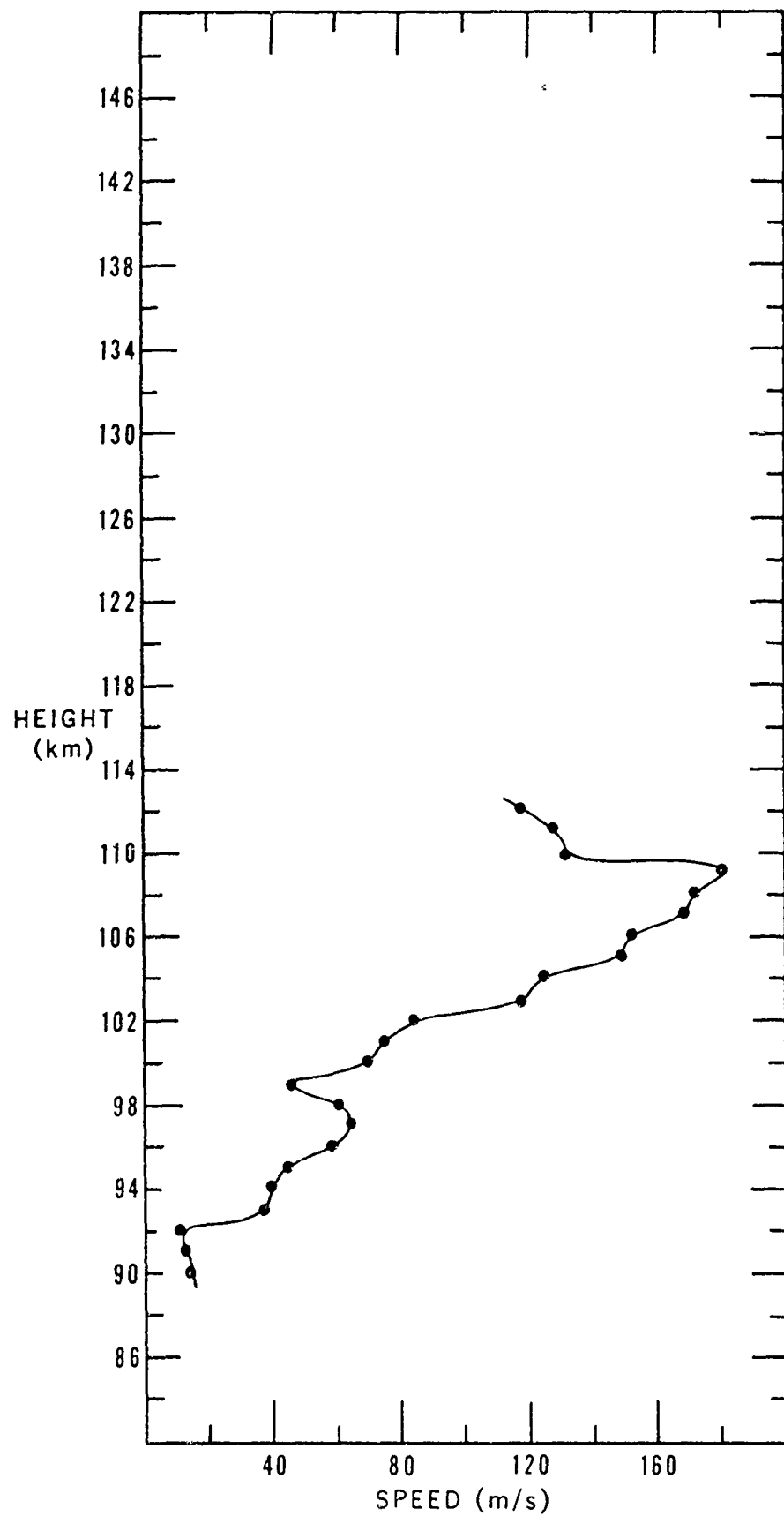
• UP

TRAIL NO. Y12

22:32:07 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

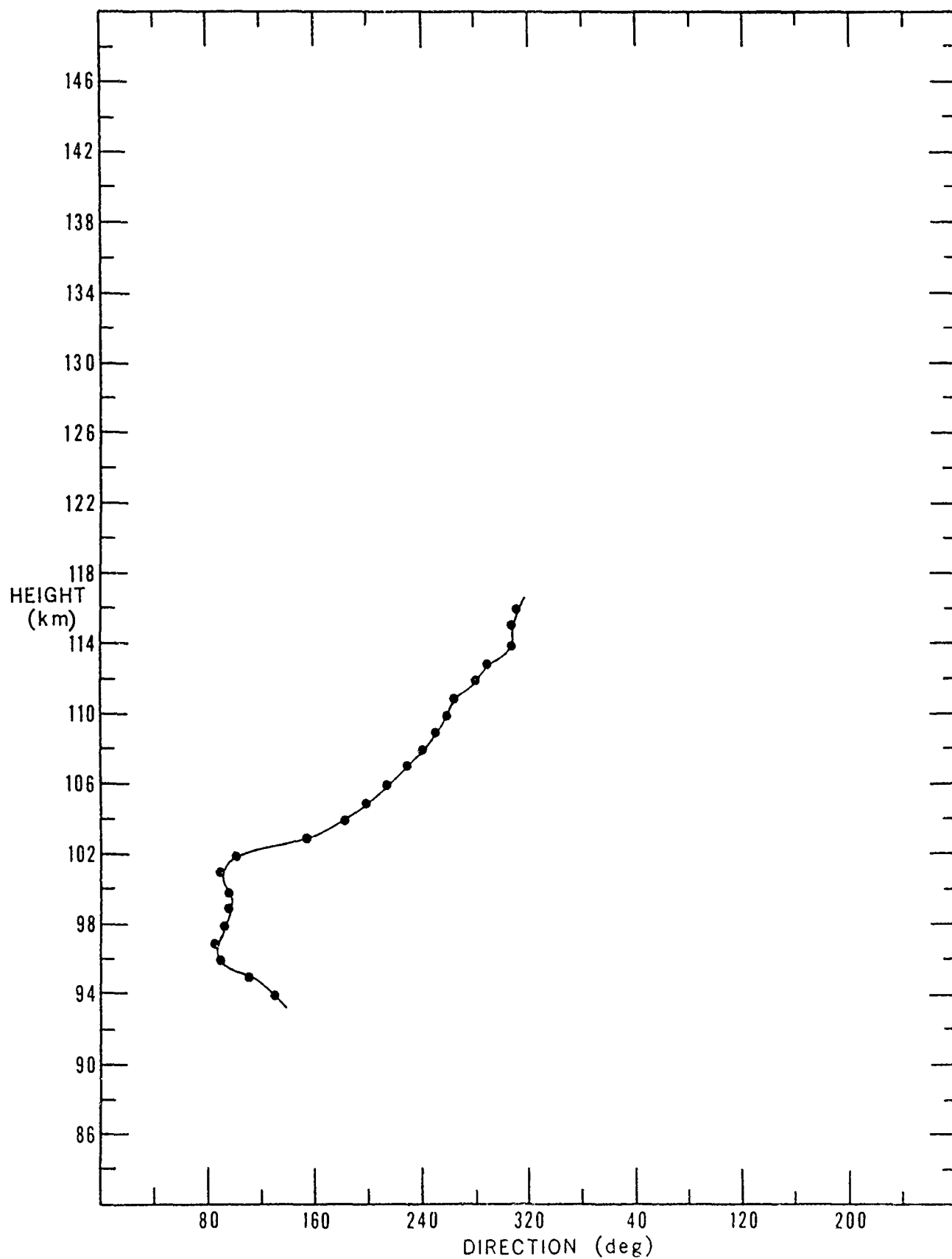
• UP

TRAIL NO. Y12

22:32:07 MST

16 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y13  
17 NOVEMBER 1966

00-16-13 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
96.0	123.2	59.9	-32.8	50.1	-19.5	56.6
97.0	146.1	59.7	-49.6	33.3	-39.9	44.5
98.0	186.6	78.3	-77.8	-5.1	-77.6	10.3
99.0	228.7	82.6	-54.5	-52.0	-68.1	-46.7
100.0	248.9	109.9	-39.6	-102.5	-63.6	-89.6
106.0	284.7	165.6	42.0	-160.2	1.3	-165.6
107.0	289.7	167.6	56.4	-157.8	15.8	-166.8
108.0	298.8	160.2	77.2	-140.4	40.3	-155.1
109.0	312.1	154.4	103.6	-114.5	72.2	-136.5
110.0	345.3	114.7	110.9	-29.2	100.3	-55.6
111.0	0.2	112.1	112.1	0.4	108.7	-27.2
112.0	16.6	117.2	112.3	33.4	117.1	4.7
113.0	28.9	129.5	113.4	62.5	125.3	32.7
116.0	34.0	116.1	96.2	65.0	109.2	39.3
118.0	36.2	93.6	75.5	55.3	86.8	35.0
119.0	38.5	68.3	53.5	42.5	62.3	28.0
120.0	44.8	59.6	42.3	42.0	51.3	30.3

## DOWNTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
103.0	274.7	150.9	12.3	-150.4	-25.1	-148.8
104.0	281.7	162.6	33.1	-159.2	-7.1	-162.4
105.0	285.5	165.7	44.4	-159.7	3.7	-165.7
106.0	290.6	162.7	57.3	-152.2	18.1	-161.6
107.0	293.8	150.6	60.7	-137.8	24.9	-148.5
108.0	301.6	146.6	75.8	-124.8	43.7	-139.9
109.0	317.4	138.8	102.2	-93.9	75.9	-116.2
110.0	338.0	119.8	111.1	-44.8	96.7	-70.8
111.0	358.0	110.6	110.5	-3.9	106.1	-21.0
112.0	15.6	117.1	112.8	31.5	117.1	2.8
113.0	26.1	127.2	114.3	55.9	124.5	26.0
114.0	32.3	131.9	111.5	70.5	125.4	40.9
115.0	35.5	120.8	98.3	70.2	112.6	43.8
116.0	37.4	102.9	81.8	62.5	94.7	40.4
117.0	37.9	87.3	68.9	53.6	80.0	35.0
118.0	39.9	67.5	51.8	43.4	66.9	29.3
119.0	46.0	49.2	34.2	35.3	41.8	15.8
120.0	55.9	43.4	24.3	25.9	32.4	28.8



# WIND COMPONENTS

UP DOWN

N-S ○ △

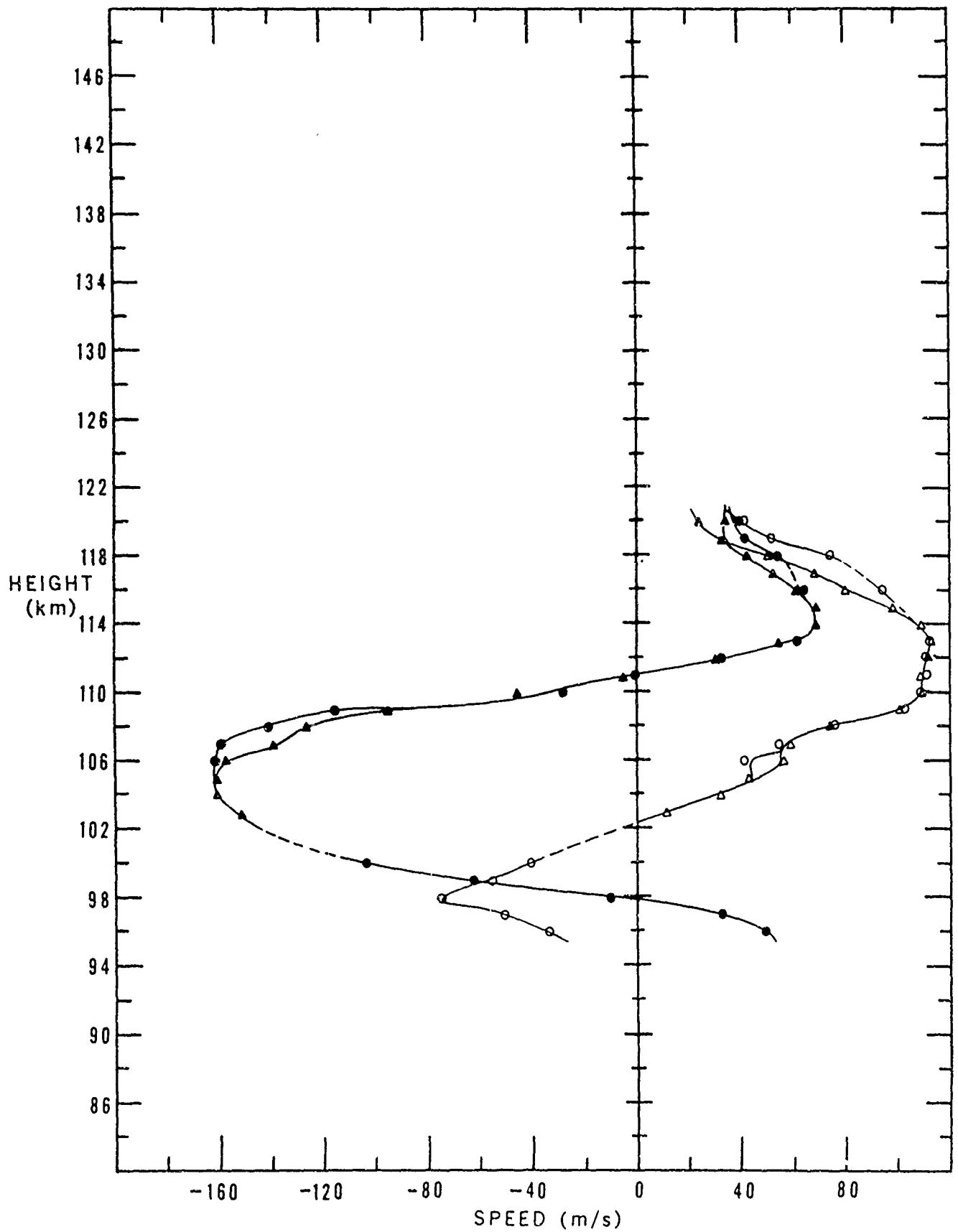
E-W ● ▲

TRAIL NO. Y13

00:16:13 MST

17 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

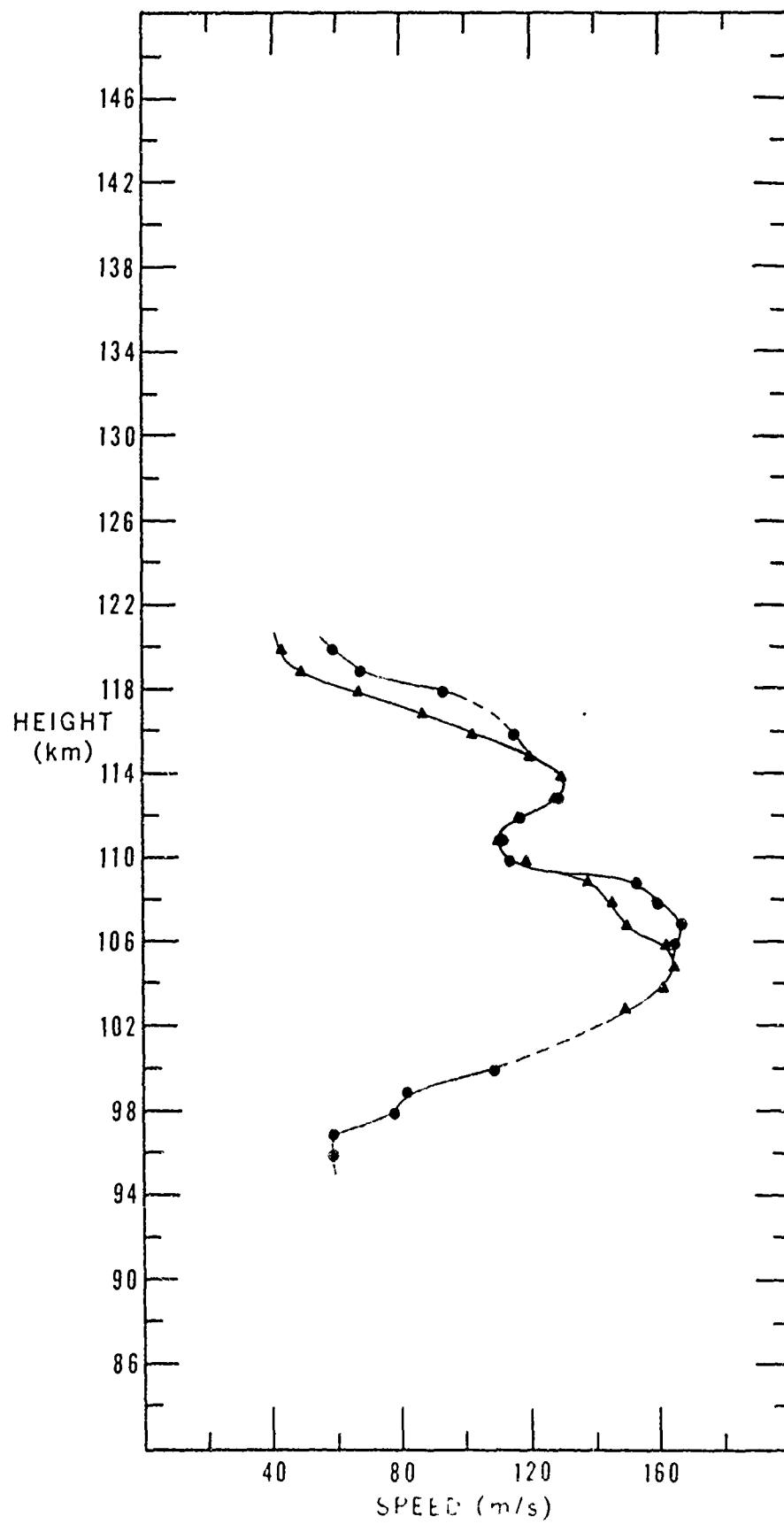
- UP
- ▲ DOWN

TRAIL NO. Y13

00:16:13 MST

17 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

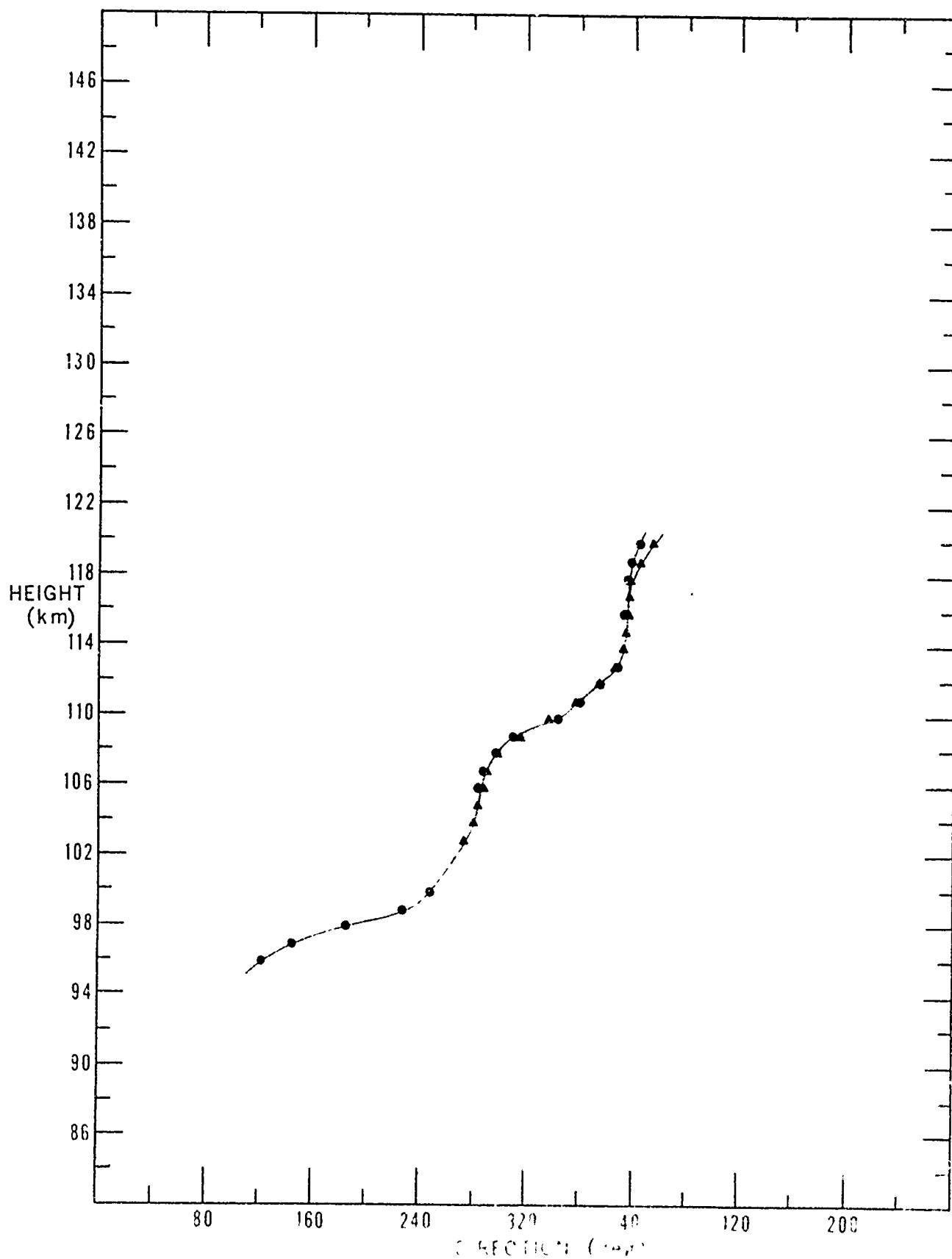
- UP
- ▲ DOWN

TRAIL NO. Y13

00:16:13 MST

17 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y14  
18 NOVEMBER 1966

18-18-47 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
88.0	202.9	42.5	-39.2	-16.6	-42.1	-6.4
89.0	210.5	46.1	-39.7	-23.4	-44.2	-12.9
90.0	224.5	43.0	-30.7	-30.2	-37.2	-21.7
91.0	228.2	45.1	-30.1	-33.6	-37.4	-25.2
92.0	228.1	47.9	-32.0	-35.6	-39.8	-26.6
93.0	231.5	49.0	-30.5	-38.4	-39.0	-29.7
94.0	255.1	56.8	-14.6	-54.9	-27.7	-49.6
95.0	269.2	61.0	-0.8	-61.0	-15.8	-58.9
96.0	287.7	49.1	14.9	-46.8	2.9	-49.0
97.0	298.6	41.4	19.8	-36.4	10.2	-40.2
98.0	311.6	36.5	24.2	-27.3	16.7	-32.4
99.0	347.7	34.0	33.2	-7.2	30.4	-15.2
100.0	13.1	40.8	39.8	9.2	40.8	-0.9
101.0	36.5	41.1	33.0	24.4	38.0	15.5
102.0	62.4	39.3	18.2	34.8	26.2	29.2
103.0	89.4	39.2	0.4	39.2	10.0	37.9
104.0	88.7	33.9	0.8	33.9	9.1	32.7
105.0	25.5	33.0	29.8	14.2	32.4	6.4
106.0	350.0	39.3	38.7	-6.8	35.8	-16.1
107.0	336.2	38.8	35.5	-15.7	30.5	-24.0
108.0	336.6	36.1	33.2	-14.4	28.6	-22.1
109.0	351.7	27.5	27.3	-4.0	25.5	-10.6
110.0	355.7	25.6	25.5	-1.9	24.2	-8.1
111.0	0.0	21.2	21.2	0.0	20.5	-5.2
112.0	16.7	12.4	11.9	3.6	12.4	0.6
113.0	88.9	7.8	0.1	7.8	2.0	7.5
114.0	126.0	14.7	-8.6	11.9	-5.4	13.7
115.0	131.2	16.8	-11.1	12.6	-7.7	14.9
116.0	132.2	20.9	-14.0	15.5	-9.8	18.5
117.0	137.0	26.0	-19.0	17.7	-14.1	21.8
118.0	141.2	26.9	-21.0	16.9	-16.2	21.5
119.0	142.9	26.0	-20.8	15.7	-16.3	20.3
120.0	151.2	24.4	-21.4	11.7	-17.9	16.6

WIND COMPONENTS

UP

N-S ○

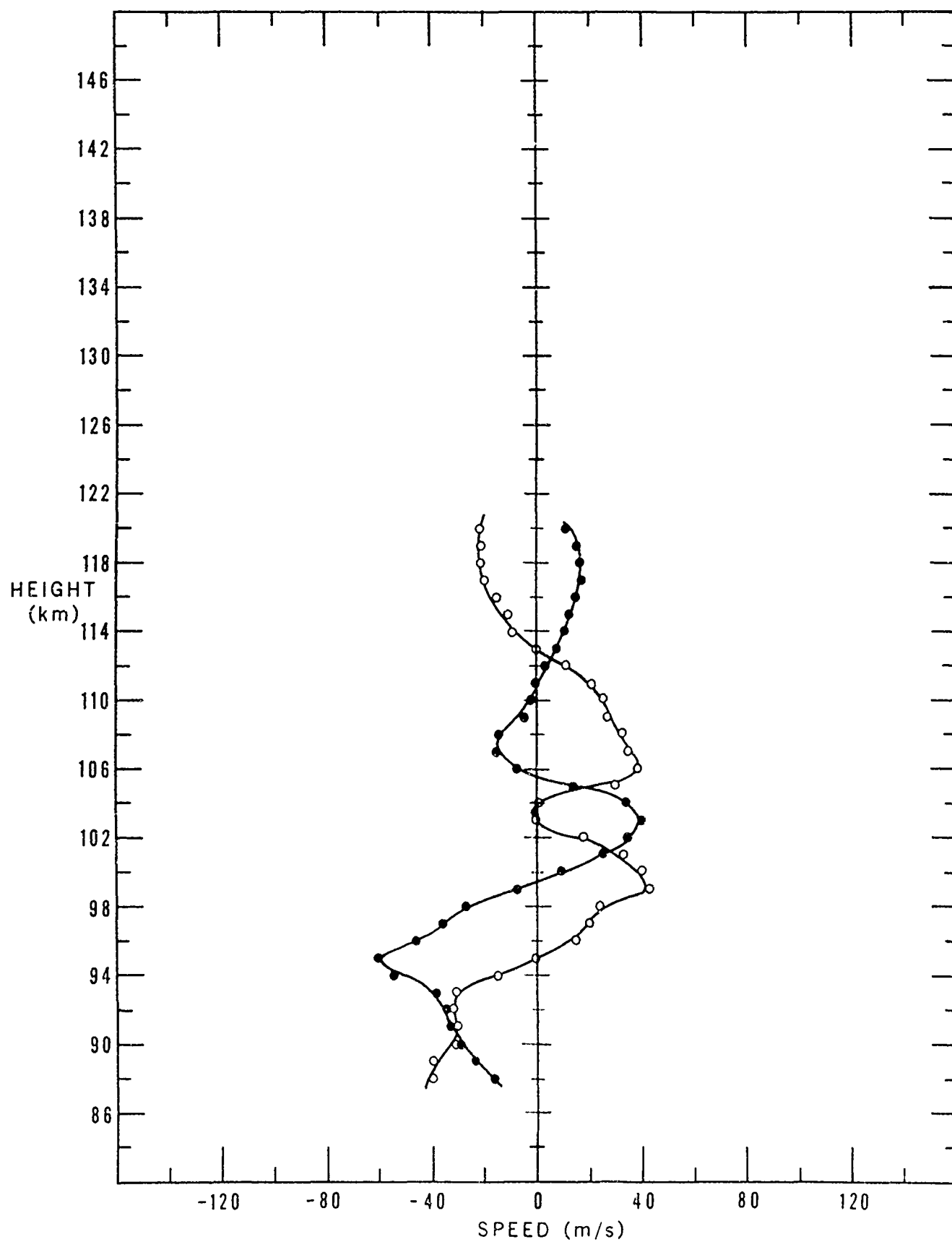
E-W ●

TRAIL NO. Y14

18:18:47 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

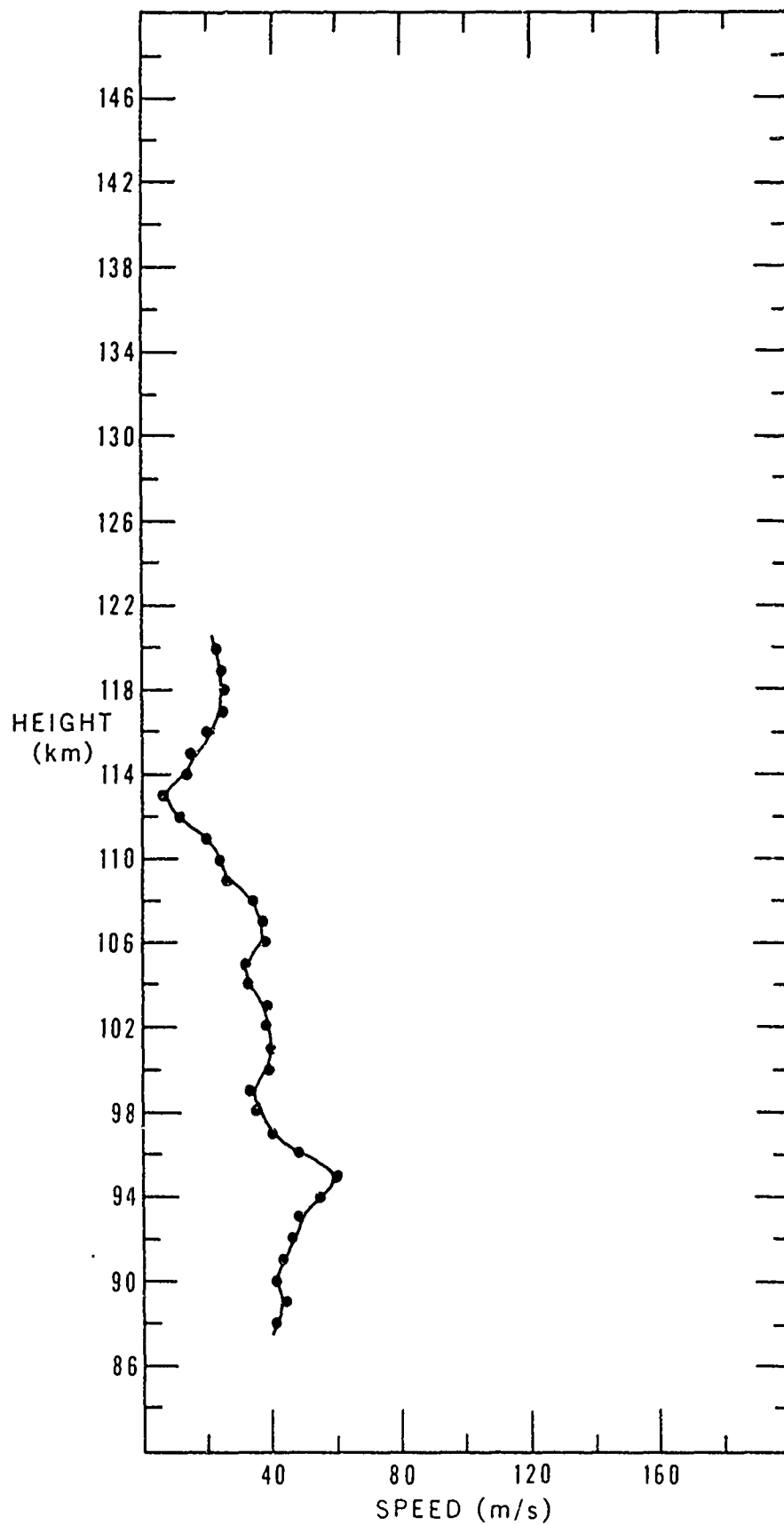
• UP

TRAIL NO. Y14

18:18:47 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

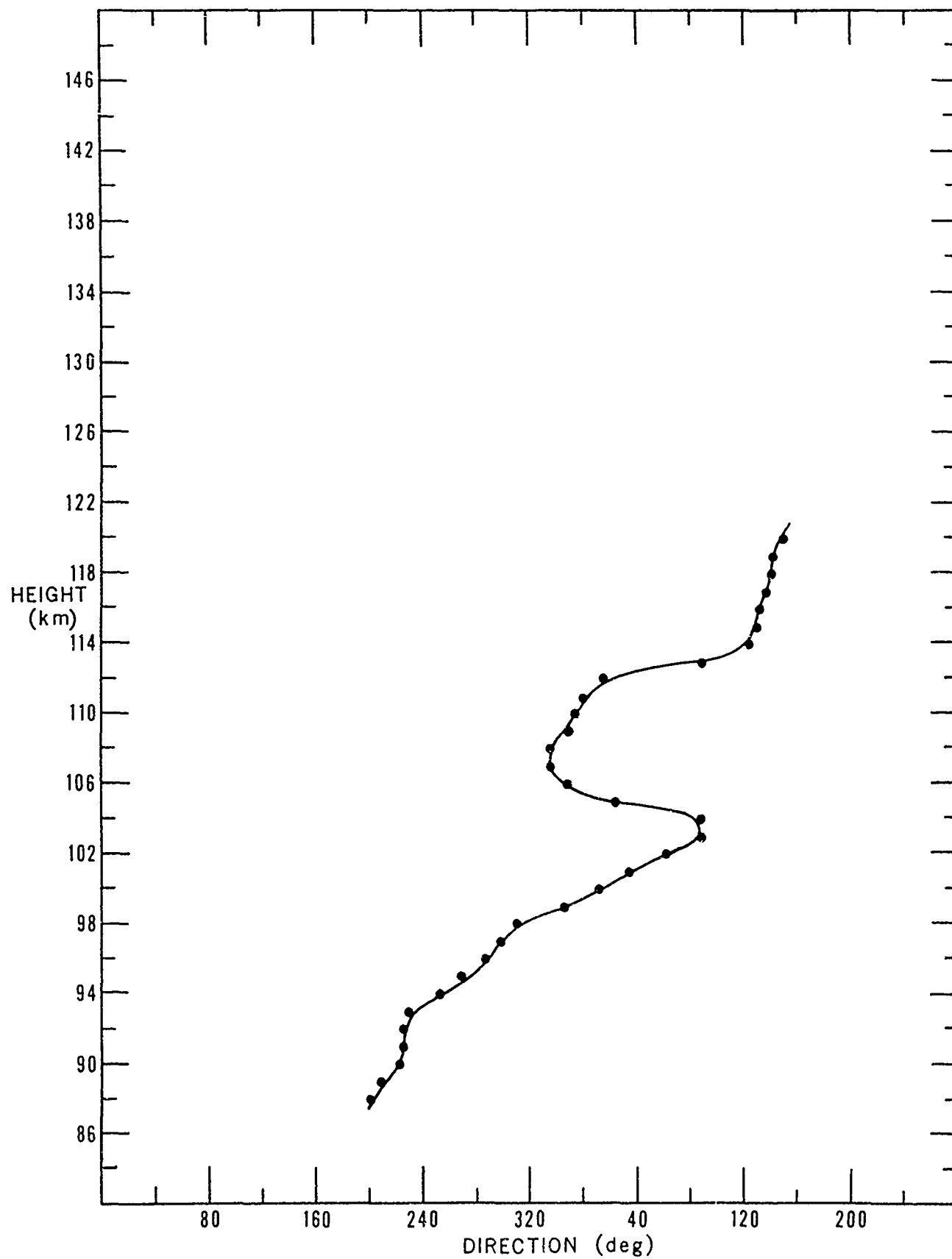
• UP

TRAIL NO. Y14

18:18:47 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NC. Y15  
18 NOVEMBER

20-12-21 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
85.0	170.3	55.4	-54.6	9.3	-50.6	22.5
86.0	183.2	51.4	-51.3	-2.9	-50.4	9.8
87.0	190.9	48.2	-47.4	-9.1	-48.2	2.8
88.0	202.6	45.3	-41.9	-17.4	-44.9	-6.6
89.0	209.6	46.1	-40.1	-22.8	-44.5	-12.2
90.0	208.5	40.0	-35.1	-19.1	-38.7	-9.9
91.0	210.4	32.0	-27.6	-16.2	-30.7	-8.9
92.0	250.6	23.8	-7.9	-22.5	-13.2	-19.9
93.0	290.1	30.4	10.4	-28.5	3.1	-30.2
94.0	329.7	26.4	20.4	-16.7	15.7	-21.2
95.0	19.1	29.2	27.6	9.6	29.1	2.5
96.0	32.6	42.1	35.4	22.7	39.9	13.3
97.0	45.5	40.3	28.2	28.8	34.4	21.0
98.0	104.7	53.9	-13.6	52.2	-0.3	53.9
99.0	118.5	67.1	-32.1	59.0	-16.6	65.1
100.0	129.2	81.1	-51.3	62.8	-34.3	73.5
101.0	135.6	85.3	-60.9	59.7	-44.3	72.9
102.0	141.4	89.8	-70.1	56.0	-54.2	71.5
103.0	146.1	89.0	-73.8	49.7	-59.3	66.3
104.0	157.3	75.9	-70.1	29.3	-60.7	45.7
105.0	205.7	17.9	-16.1	-7.8	-17.5	-3.6
106.0	227.5	14.0	-9.5	-10.3	-11.7	-7.6
107.0	258.2	11.2	-2.3	-11.0	-4.9	-10.1
108.0	307.8	10.0	6.1	-7.9	4.0	-9.2
109.0	349.4	17.0	16.7	-3.1	15.4	-7.1
110.0	353.1	19.5	19.4	-2.3	18.2	-7.0
111.0	351.8	20.9	20.7	-3.0	19.3	-8.0
112.0	348.4	22.9	22.4	-4.6	20.6	-10.0
113.0	344.9	23.0	22.2	-6.0	20.0	-11.3
114.0	343.7	22.7	21.8	-6.4	19.6	-11.6
115.0	338.1	21.4	19.9	-8.0	17.3	-12.7
116.0	315.5	17.4	12.4	-12.2	9.0	-14.9
117.0	281.2	14.4	2.8	-14.1	-0.8	-14.4
118.0	258.3	20.7	-4.2	-20.3	-9.1	-18.6
119.0	243.5	20.1	-9.0	-18.0	-13.2	-15.2
120.0	229.9	23.9	-15.4	-18.3	-19.4	-15.9
121.0	222.4	29.0	-21.4	-19.6	-25.6	-13.7
122.0	229.4	28.2	-18.3	-21.4	-23.0	-16.2
123.0	227.0	37.2	-25.4	-27.2	-31.3	-20.1
124.0	229.8	41.5	-26.8	-31.7	-33.8	-24.1
125.0	234.8	45.2	-26.0	-36.9	-34.3	-29.4
126.0	240.1	55.1	-27.5	-47.8	-38.4	-39.6



# DOWNTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
101.0	146.6	76.5	-63.8	42.2	-51.4	56.6
102.0	150.3	66.4	-57.7	32.8	-47.9	46.0
103.0	150.2	60.7	-52.7	30.2	-43.6	42.2
104.0	158.0	46.8	-43.3	17.5	-37.7	27.6
105.0	215.5	20.5	-16.7	-11.9	-19.1	-7.4
106.0	257.3	21.8	-4.8	-21.3	-9.9	-19.5
107.0	275.9	21.2	2.2	-21.1	-3.1	-21.0
108.0	298.7	16.3	7.8	-14.3	4.0	-15.8
109.0	352.9	12.4	12.3	-1.5	11.6	-4.5
110.0	359.4	16.9	16.9	-0.2	16.3	-4.4
111.0	344.2	22.6	21.7	-6.1	19.5	-11.3
112.0	336.6	26.6	24.4	-10.6	21.0	-16.3
113.0	328.4	27.4	23.3	-14.3	19.1	-19.6
114.0	321.7	26.3	20.6	-16.3	16.0	-20.9
115.0	311.5	25.1	16.6	-18.8	11.5	-22.3
116.0	298.0	23.5	11.0	-20.7	5.6	-22.8
117.0	283.3	21.4	4.9	-20.8	-0.4	-21.4
118.0	266.9	21.0	-1.1	-20.9	-6.2	-20.0
119.0	250.1	21.9	-7.4	-20.6	-12.2	-18.1
120.0	229.6	21.8	-14.1	-16.6	-17.8	-12.6
121.0	220.9	24.6	-18.6	-16.1	-22.0	-11.0
122.0	219.1	23.7	-18.4	-14.9	-21.5	-9.9
123.0	216.8	18.9	-15.1	-11.3	-17.4	-7.2
124.0	218.0	14.5	-11.4	-8.9	-13.2	-5.8
125.0	219.9	9.9	-7.6	-6.3	-8.9	-4.2
126.0	215.8	3.5	-2.9	-2.1	-3.3	-1.3
127.0	42.6	3.8	2.8	2.6	3.4	1.8

# WIND COMPONENTS

UP DOWN

N-S ○ △

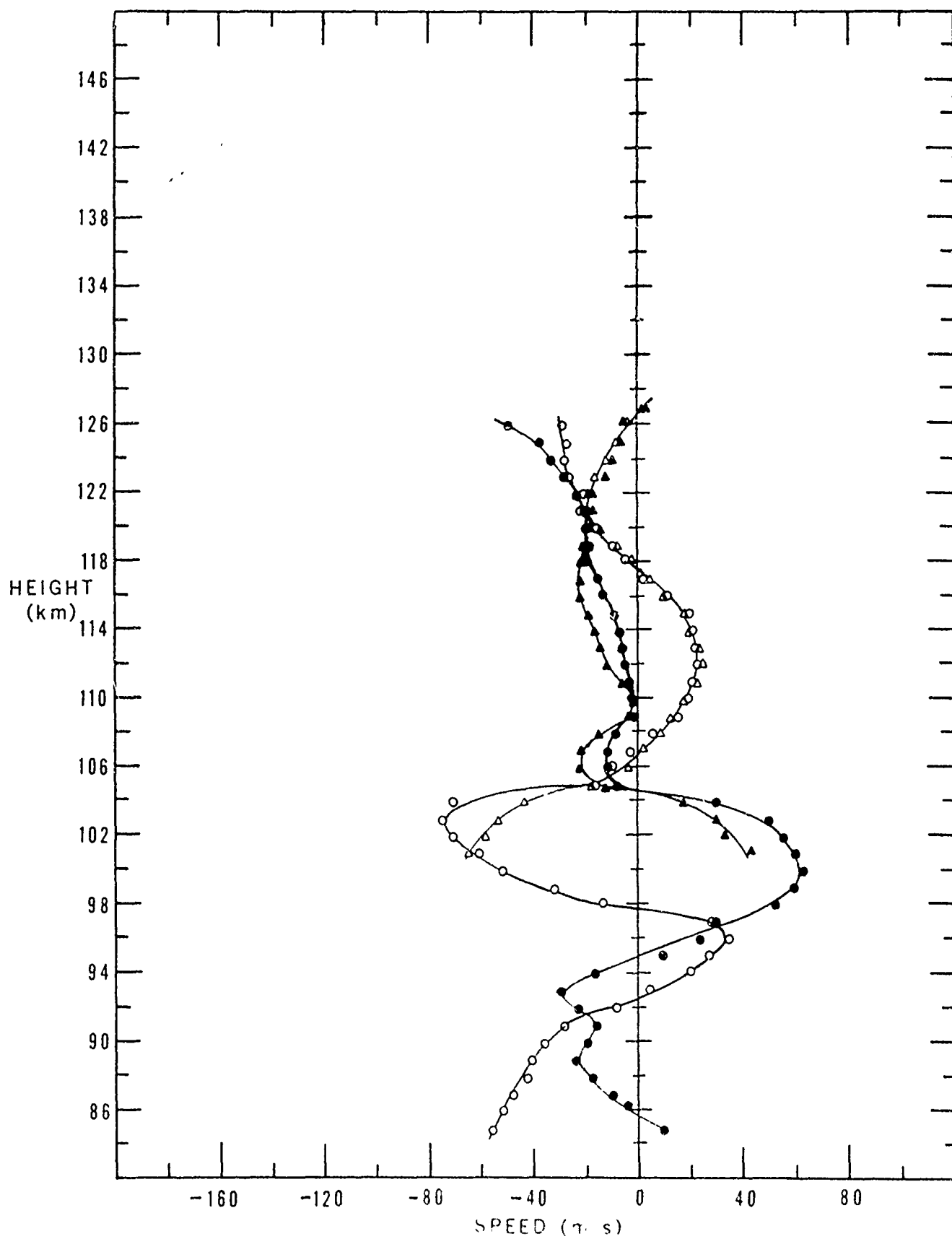
E-W ● ▲

TRAIL NO. Y15

20:12:21 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

• UP

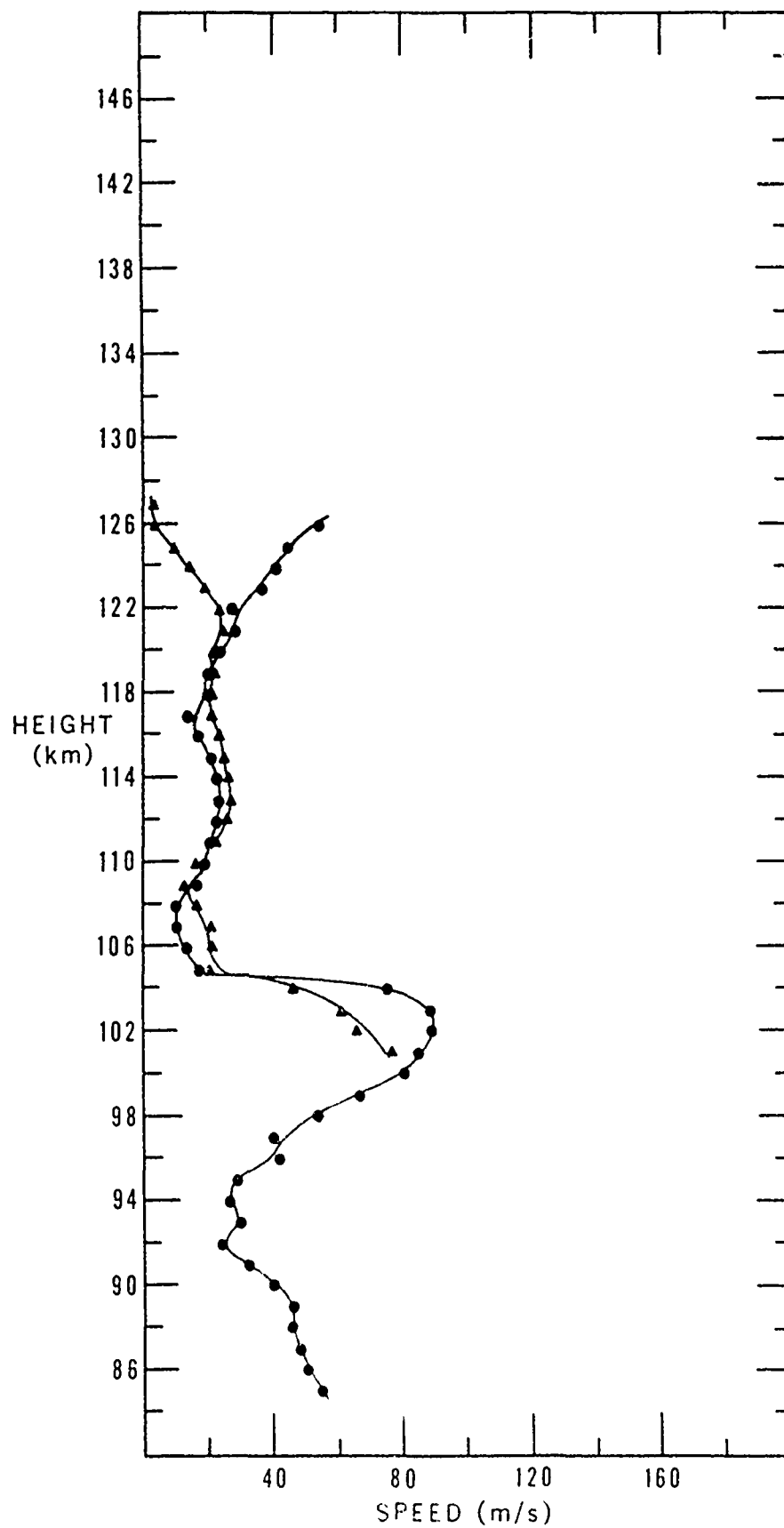
▲ DOWN

TRAIL NO. Y15

20:12:21 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

• UP

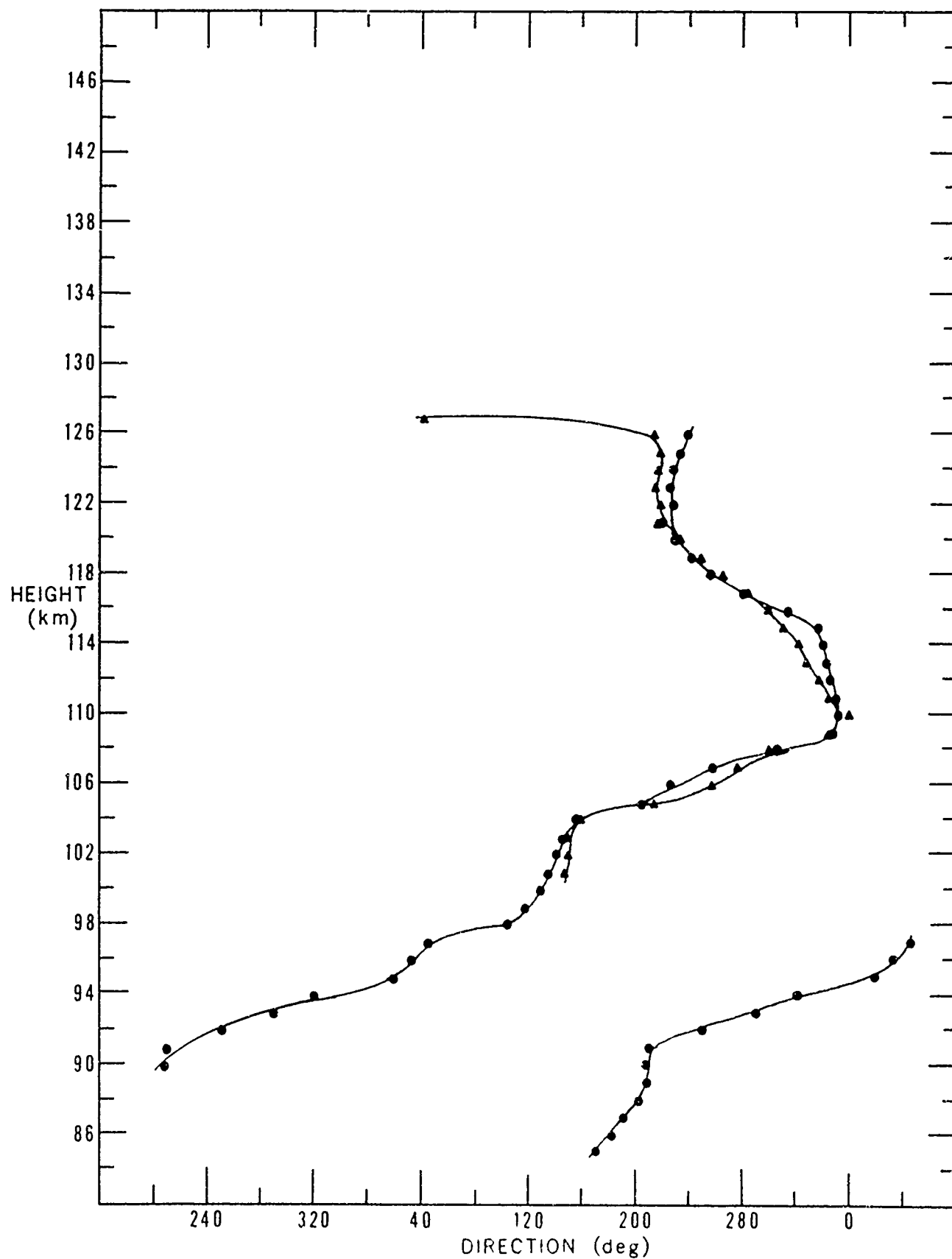
▲ DOWN

TRAIL NO. Y15

20:12:21 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y16  
18 NOVEMBER 1966

21-49-42 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
89.0	268.5	26.1	-0.7	-26.1	-7.1	-25.1
90.0	268.6	28.6	-0.7	-28.6	-7.7	-27.5
91.0	270.6	21.1	0.2	-21.1	-5.0	-20.5
92.0	271.0	18.5	0.3	-18.5	-4.3	-18.0
93.0	287.8	18.3	5.6	-17.4	1.1	-18.2
94.0	352.3	4.6	4.5	-0.6	4.2	-1.7
95.0	98.8	18.0	-2.8	17.8	1.7	17.9
96.0	105.9	32.0	-8.8	30.8	-0.9	32.0
97.0	107.7	39.4	-12.0	37.5	-2.4	39.3
98.0	110.1	43.1	-14.8	40.4	-4.4	42.8
99.0	116.3	53.9	-23.9	48.3	-11.3	52.7
100.0	126.2	63.7	-37.6	51.4	-23.8	59.1
101.0	155.5	54.2	-49.3	22.5	-42.2	33.9
102.0	200.5	46.2	-43.3	-16.1	-45.9	-4.9
103.0	229.6	38.5	-25.0	-29.3	-31.4	-22.2
104.0	249.3	33.9	-12.0	-31.7	-19.4	-27.8
105.0	257.1	35.4	-7.9	-34.5	-16.1	-31.5
106.0	261.8	37.2	-5.3	-36.9	-14.2	-34.5
107.0	265.1	39.5	-3.4	-39.4	-13.0	-37.4
108.0	267.4	41.0	-1.9	-41.0	-11.9	-39.3
109.0	266.5	43.9	-2.7	-43.8	-13.4	-41.8
110.0	269.8	43.3	-0.2	-43.3	-10.9	-41.9
111.0	272.1	42.0	1.5	-41.9	-8.9	-41.0
112.0	284.3	36.5	9.0	-35.4	0.0	-36.5
113.0	291.9	35.7	13.3	-33.1	4.7	-35.4
114.0	293.4	35.1	13.9	-32.2	5.5	-34.6
115.0	302.8	36.6	19.9	-30.8	11.7	-34.8
116.0	312.4	39.7	26.8	-29.4	18.7	-35.1
117.0	317.8	38.9	28.8	-26.1	21.5	-32.4
118.0	324.8	39.9	32.6	-23.0	25.9	-30.3
119.0	333.4	43.2	38.6	-19.4	32.6	-28.3
120.0	337.9	47.6	44.1	-17.9	38.3	-28.2
121.0	345.3	50.8	49.2	-12.9	44.5	-24.6
122.0	352.7	54.0	53.5	-6.9	50.2	-19.9
123.0	0.3	57.2	57.2	0.3	55.5	-13.8
124.0	12.0	61.9	60.6	12.9	61.9	-2.4
125.0	16.4	64.1	61.5	18.1	64.1	2.4

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
126.0	27.5	68.7	61.0	31.7	66.9	15.7
127.0	35.3	70.7	57.7	40.9	66.0	25.4
128.0	43.9	72.0	51.8	49.9	62.5	35.6
129.0	53.1	71.9	43.1	57.5	55.9	45.1
130.0	61.1	71.6	34.6	62.7	49.0	52.3
131.0	73.8	71.2	19.8	68.4	36.0	61.4
132.0	88.9	74.4	1.5	74.4	19.8	71.7
133.0	100.1	80.3	-14.1	79.0	5.8	80.0
134.0	106.3	87.8	-24.7	84.2	-3.2	87.7
135.0	112.3	89.9	-34.1	83.2	-12.6	89.0
136.0	117.4	95.8	-44.1	85.1	-21.8	93.3
137.0	119.2	92.3	-45.0	80.6	-23.8	89.2
138.0	122.8	92.4	-50.0	77.7	-29.3	87.6
139.0	125.8	92.1	-53.9	74.7	-33.9	85.7

# WIND COMPONENTS

UP

N-S ○

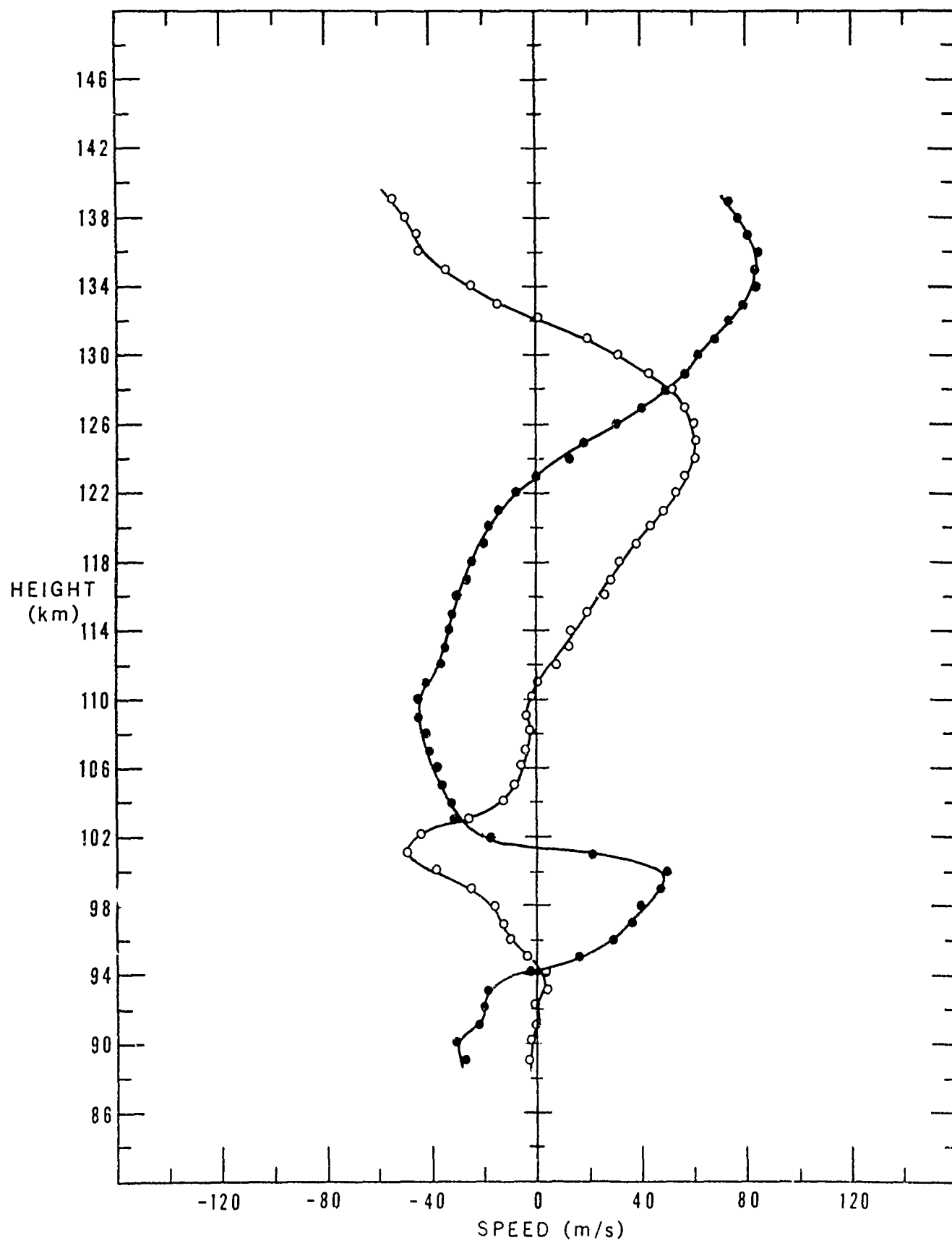
E-W ●

TRAIL NO. Y16

21:49:42 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

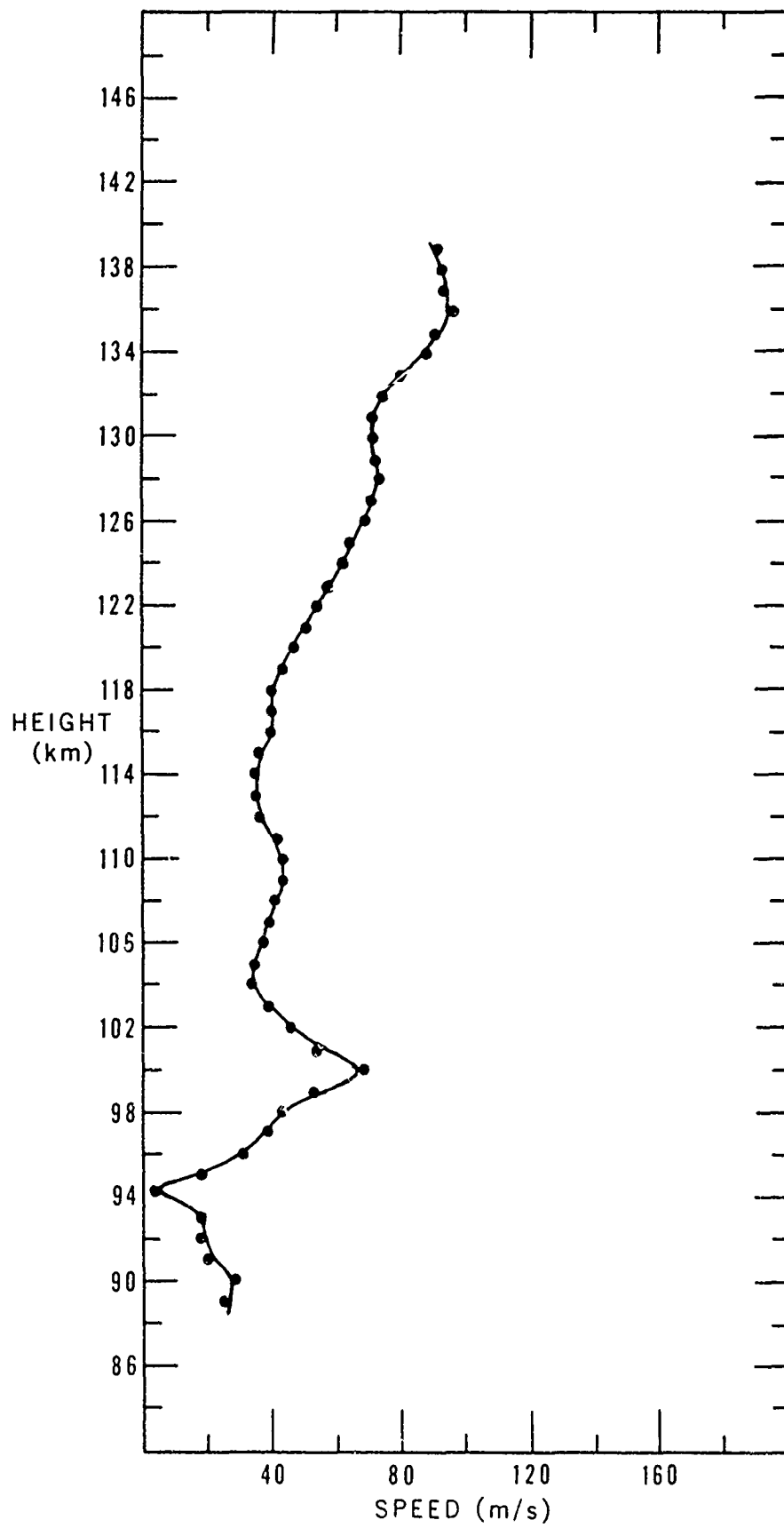
• UP

TRAIL NO. Y16

21:49:42 MST

18 NOVEMBER 1966

H.A.R.P. YUMA





WIND DIRECTION

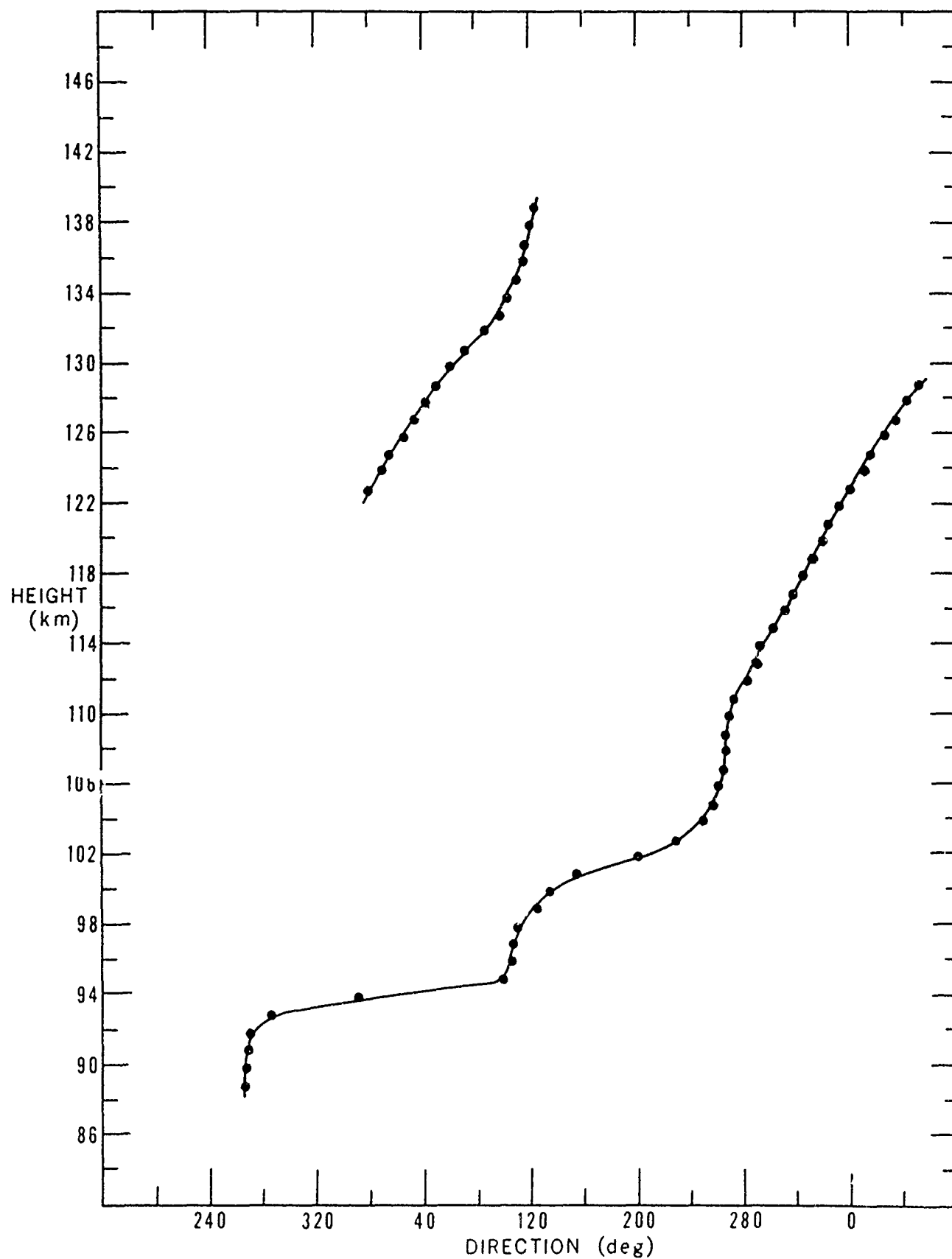
• UP

TRAIL NO. Y16

21:49:42 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y17  
18 NOVEMBER 1966

23-43-09 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
89.0	25.5	38.8	35.0	16.7	38.0	7.6
90.0	32.4	40.5	34.2	21.7	38.5	12.6
91.0	39.9	44.9	34.5	28.8	40.5	19.4
92.0	47.1	51.4	35.0	37.7	43.2	27.9
93.0	73.5	44.4	12.7	42.6	22.8	38.2
94.0	97.8	35.2	-4.8	34.8	3.9	34.9
95.0	118.9	32.6	-15.8	28.5	-8.3	31.5
96.0	126.8	38.6	-23.1	30.9	-14.8	35.6
97.0	122.6	45.9	-24.7	38.7	-14.4	43.6
98.0	120.2	55.6	-28.0	48.1	-15.3	53.5
99.0	130.4	55.7	-36.1	42.4	-24.6	50.0
100.0	179.7	55.0	-55.0	0.3	-53.2	13.8
101.0	209.1	71.0	-62.0	-34.6	-68.6	-18.3
102.0	234.4	95.4	-55.5	-77.5	-72.9	-61.5
103.0	239.0	90.2	-46.4	-77.4	-64.0	-63.6
104.0	243.1	91.7	-41.5	-81.7	-60.3	-69.0
105.0	255.6	93.2	-23.1	-90.3	-44.6	-81.8
106.0	264.1	102.2	-10.5	-101.7	-35.2	-96.0
107.0	265.9	109.3	-7.9	-109.0	-34.5	-103.7
108.0	281.3	108.9	21.4	-106.7	-5.5	-108.7
109.0	296.9	88.9	40.3	-79.3	19.5	-86.8
110.0	316.5	74.2	53.8	-51.0	39.6	-62.7
111.0	338.3	72.1	66.9	-26.7	58.3	-42.3
112.0	345.4	67.5	65.3	-17.0	59.1	-32.6
113.0	345.6	67.3	65.2	-16.8	59.1	-32.3
114.0	353.8	64.3	63.9	-7.0	60.2	-22.5
115.0	2.3	61.6	61.5	2.5	60.2	-12.7
116.0	2.4	62.6	62.6	2.6	61.3	-12.9
117.0	5.9	59.6	59.3	6.1	59.0	-8.7
118.0	11.2	55.1	54.1	10.7	55.1	-2.9
119.0	23.4	47.8	43.8	19.0	47.1	7.6
120.0	42.6	45.7	33.7	30.9	40.3	21.7
121.0	60.8	47.5	23.2	41.4	32.7	34.4
122.0	76.6	49.4	11.5	48.0	23.0	43.7
123.0	91.7	54.5	-1.6	54.5	11.9	53.2
124.0	104.1	55.5	-13.5	53.8	0.2	55.5
125.0	114.6	53.5	-22.3	48.7	-9.6	52.7

CONTINUED

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC		MAGNETIC	
			WIND COMPONENTS (M/S)		WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
126.0	126.1	55.6	-32.8	44.9	-20.7	51.6
127.0	138.8	59.3	-44.7	39.1	-33.7	48.9
128.0	149.6	63.4	-54.7	32.0	-45.1	44.5
129.0	157.3	68.9	-63.6	26.6	-55.1	41.4
130.0	163.3	73.1	-70.0	20.9	-62.7	37.5
131.0	163.9	81.8	-78.6	22.7	-70.6	41.3
132.0	170.1	78.5	-77.4	13.5	-71.7	32.1
133.0	172.9	74.6	-74.0	9.3	-69.4	27.2
134.0	176.6	76.8	-76.6	4.6	-73.1	23.3
135.0	177.8	77.2	-77.1	3.0	-74.0	21.9
136.0	178.9	78.4	-78.4	1.5	-75.6	20.8
137.0	181.5	74.5	-74.5	-2.0	-72.7	16.4
138.0	188.8	74.3	-73.4	-11.4	-73.9	7.0

# WIND COMPONENTS

UP

N-S ○

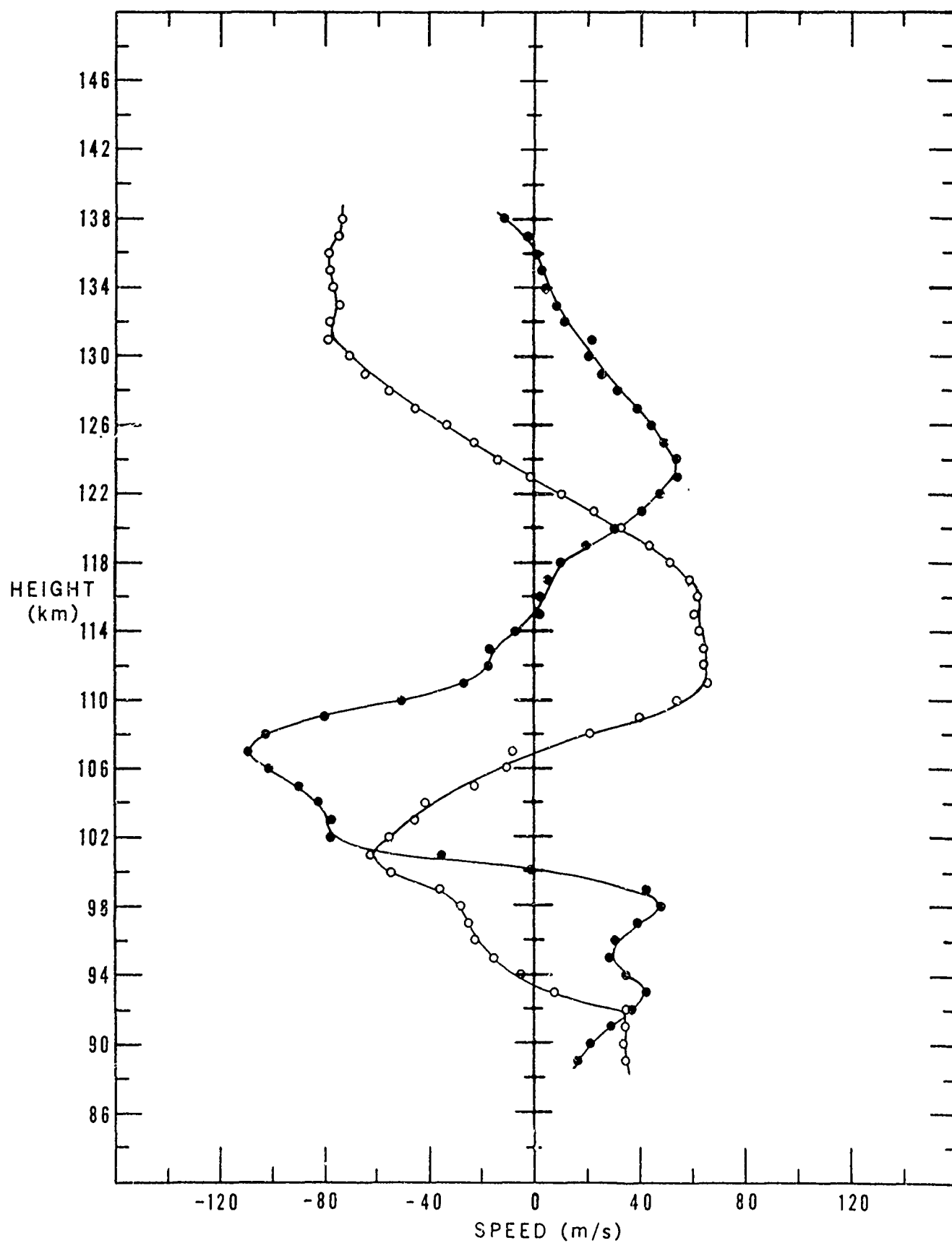
E-W ●

TRAIL NO. Y17

23:43:09 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

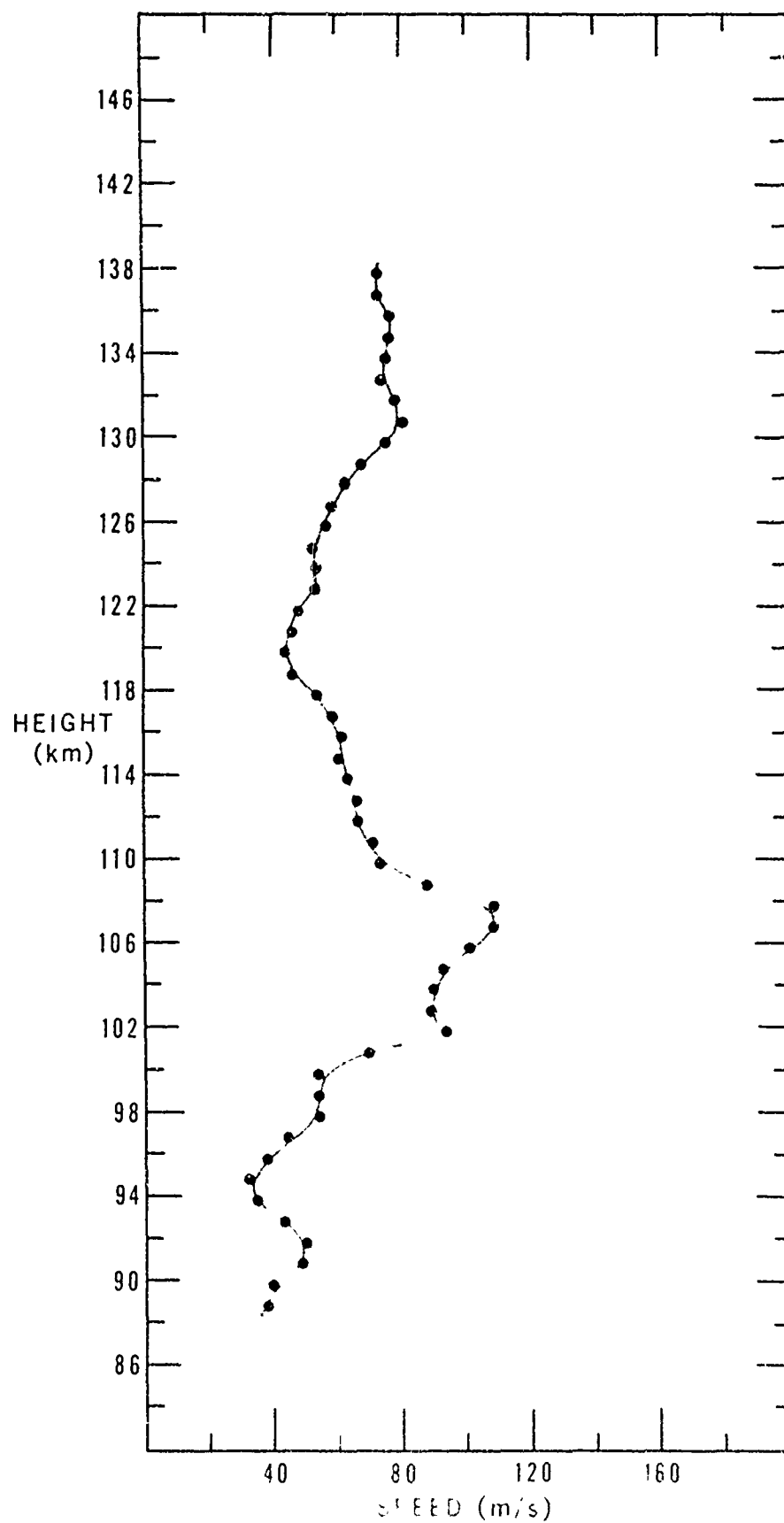
• UP

TRAIL NO. Y17

23:43:09 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

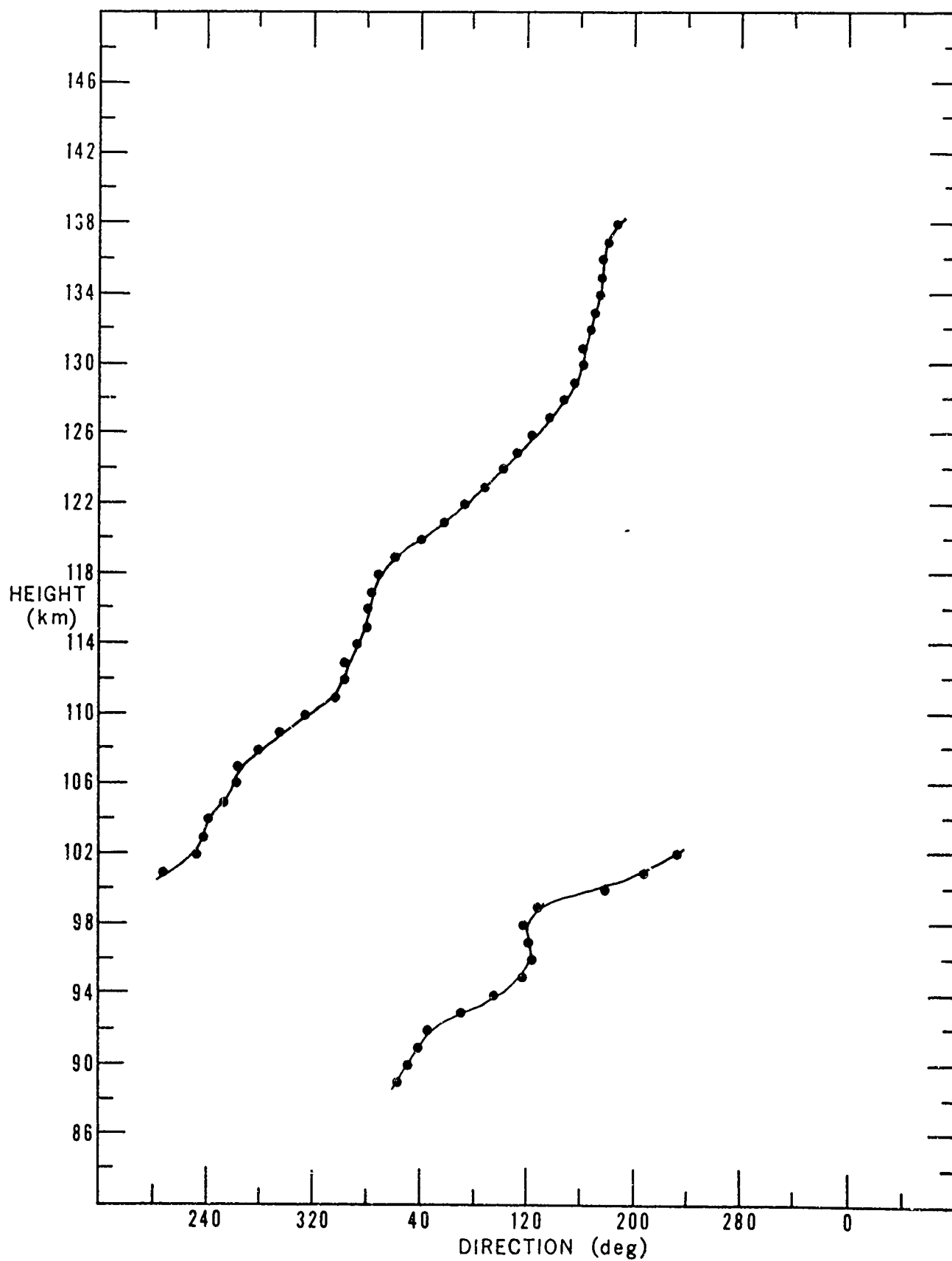
• UP

TRAIL NO. Y17

23:43:09 MST

18 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y18  
19 NOVEMBER 1966

01-01-22 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC	
			N-S	E-W	N-S	E-W
91.0	55.9	39.6	22.2	32.8	29.6	26.3
92.0	76.9	53.7	12.1	52.3	24.6	47.7
93.0	101.5	47.6	-9.5	46.7	2.3	47.6
94.0	139.3	35.6	-27.0	23.2	-20.5	29.1
95.0	155.8	42.4	-38.7	17.4	-33.2	26.4
96.0	164.7	52.9	-51.1	13.9	-46.1	26.1
97.0	172.4	63.8	-63.2	8.4	-59.2	23.7
98.0	199.6	109.4	-103.1	-36.6	-108.9	-10.1
99.0	215.7	111.9	-90.9	-65.2	-104.2	-40.8
100.0	225.2	116.4	-82.1	-82.5	-99.9	-59.8
101.0	234.1	126.1	-73.9	-102.2	-96.8	-80.9
102.0	253.9	123.9	-34.4	-119.0	-62.6	-106.9
104.0	278.2	138.4	19.7	-137.0	-14.6	-137.6
103.0	265.0	126.7	-11.0	-126.2	-41.7	-119.6
105.0	294.8	130.9	54.8	-118.9	23.8	-128.7
106.0	310.0	120.6	77.5	-92.4	52.4	-108.6
107.0	321.1	106.1	82.6	-66.6	63.7	-84.9
108.0	329.2	98.4	84.5	-50.4	69.5	-69.6
109.0	336.6	94.6	86.8	-37.5	74.9	-57.7
110.0	341.3	91.1	86.2	-29.3	76.3	-49.6
111.0	358.3	74.0	74.0	-1.9	71.3	-20.1
112.0	7.7	66.7	66.1	8.9	66.3	-7.6
113.0	13.1	61.9	60.3	14.1	61.9	-1.2
114.0	20.6	57.5	53.8	20.2	57.1	6.3
115.0	27.4	56.2	49.9	25.8	54.7	12.7
116.0	34.8	61.1	50.2	34.8	57.2	21.4
117.0	43.1	64.8	47.3	44.3	56.7	31.3
118.0	52.1	61.9	38.0	48.8	48.8	37.9
119.0	61.1	57.4	27.8	50.3	39.3	41.9
120.0	74.0	53.1	14.6	51.1	26.7	45.9
121.0	86.8	50.3	2.8	50.2	15.1	48.0
122.0	104.3	49.7	-12.3	48.1	-0.1	49.6
123.0	117.6	51.5	-23.9	45.7	-11.9	50.2
124.0	132.0	54.2	-36.2	40.3	-25.2	48.0
125.0	140.8	56.8	-44.0	35.9	-33.8	45.6

CONTINUED

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
126.0	149.4	58.7	-50.5	29.9	-41.6	41.4
127.0	155.8	59.9	-54.6	24.6	-46.9	37.3
128.0	163.5	59.4	-56.9	16.9	-51.0	30.4
129.0	170.8	59.0	-58.3	9.5	-54.2	23.6
130.0	177.7	56.6	-56.6	2.3	-54.3	16.2
131.0	183.6	51.9	-51.8	-3.2	-51.0	9.6
132.0	189.2	47.5	-46.9	-7.6	-47.3	4.2
133.0	195.1	45.8	-44.2	-11.9	-45.8	-0.7
134.0	201.1	43.8	-40.9	-15.7	-43.5	-5.1
135.0	209.0	40.6	-35.6	-19.7	-39.4	-10.3
136.0	216.6	38.9	-31.2	-23.2	-36.0	-14.8
137.0	223.1	36.7	-26.8	-25.1	-32.2	-17.7
138.0	230.4	32.5	-20.7	-25.1	-26.2	-19.2
139.0	241.6	31.1	-14.8	-27.3	-21.1	-22.8
140.0	250.4	25.5	-8.6	-24.0	-14.2	-21.1
141.0	265.0	23.6	-2.0	-23.6	-7.7	-22.4
142.0	271.6	21.9	0.6	-21.9	-4.8	-21.4
143.0	267.7	23.0	-0.9	-23.0	-6.5	-22.1
144.0	274.1	25.5	1.8	-25.5	-4.5	-25.2



# WIND COMPONENTS

UP

N-S ○

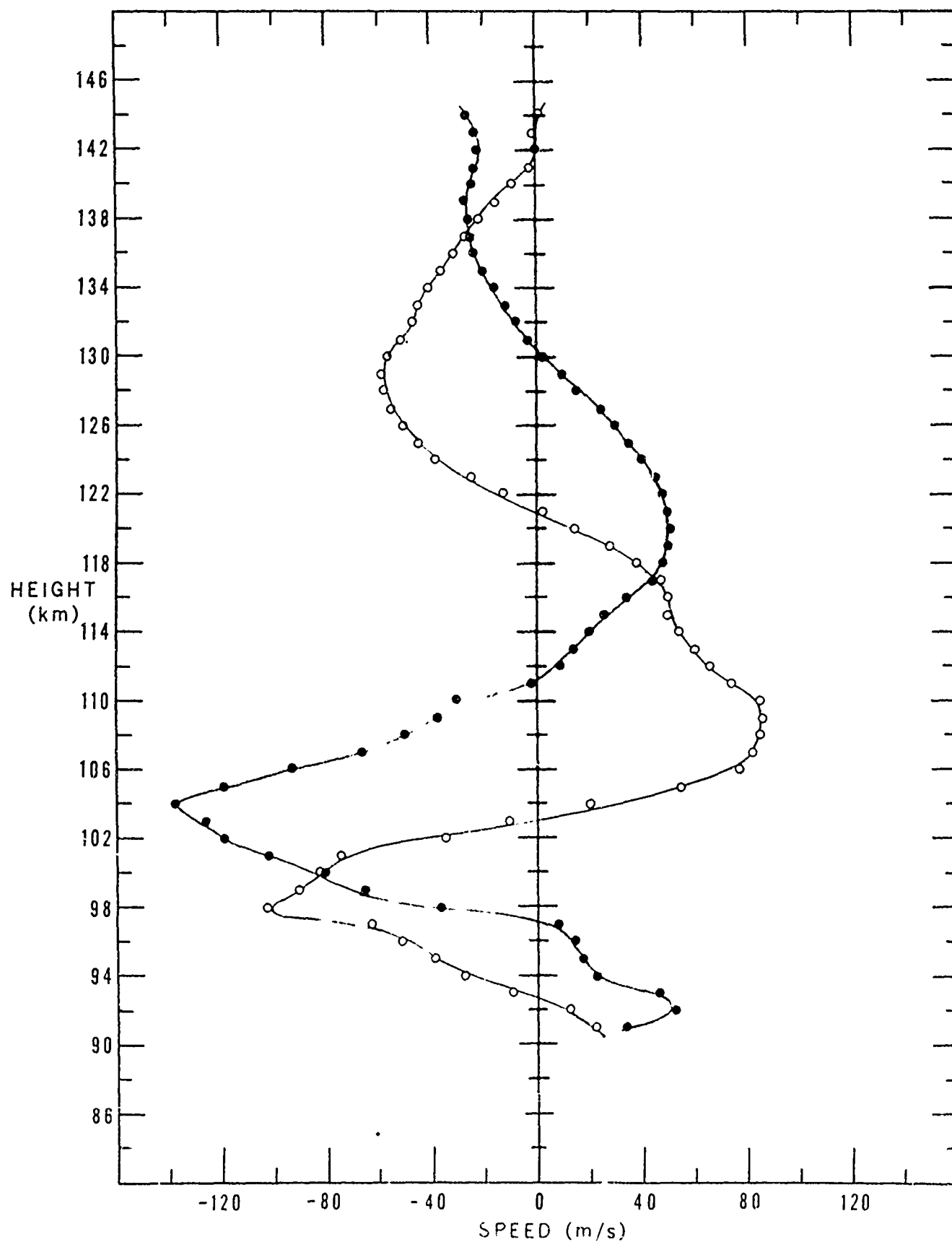
E-W ●

TRAIL NO. Y18

01:01:22 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

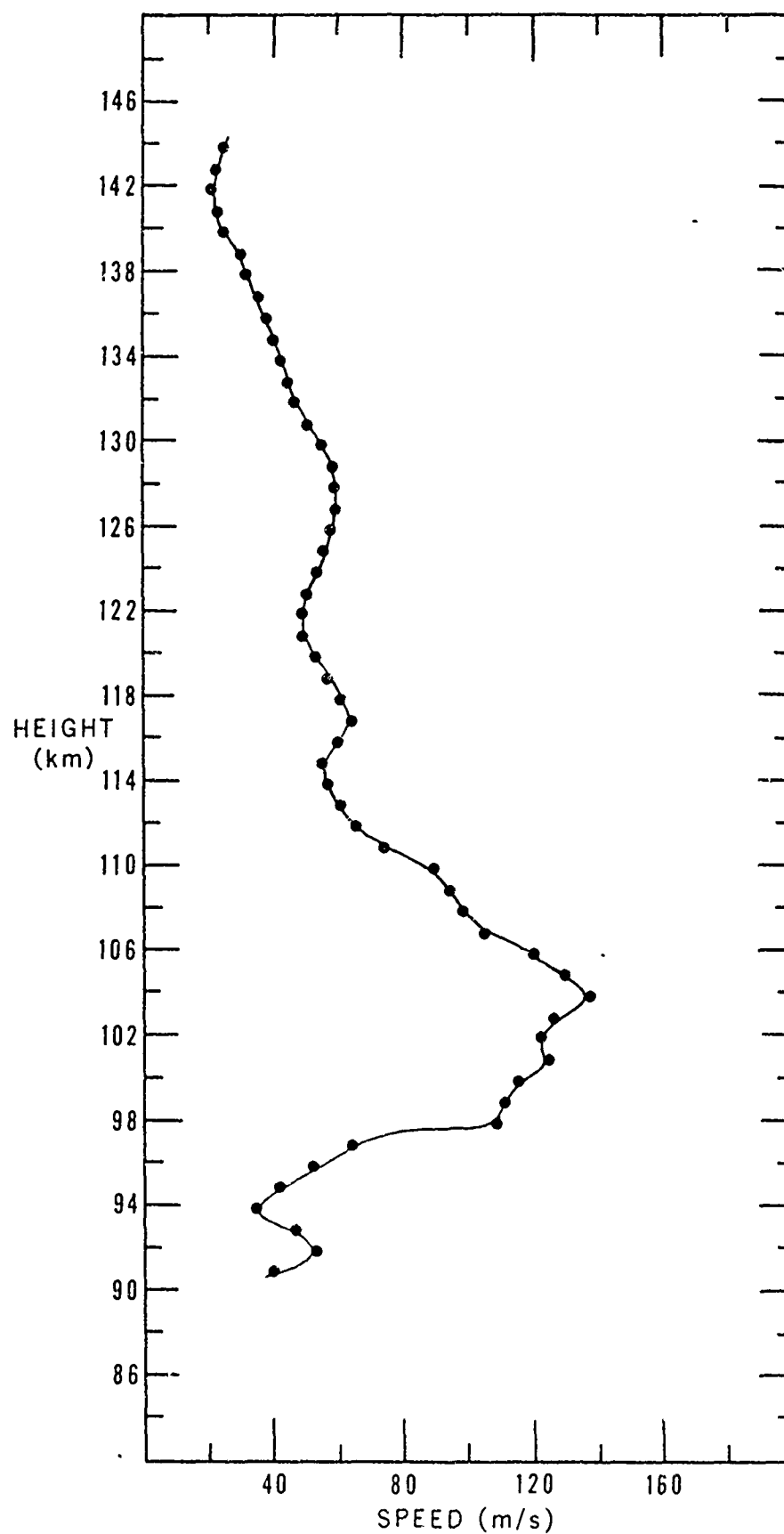
• UP

TRAIL NO. Y18

01:01:22 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

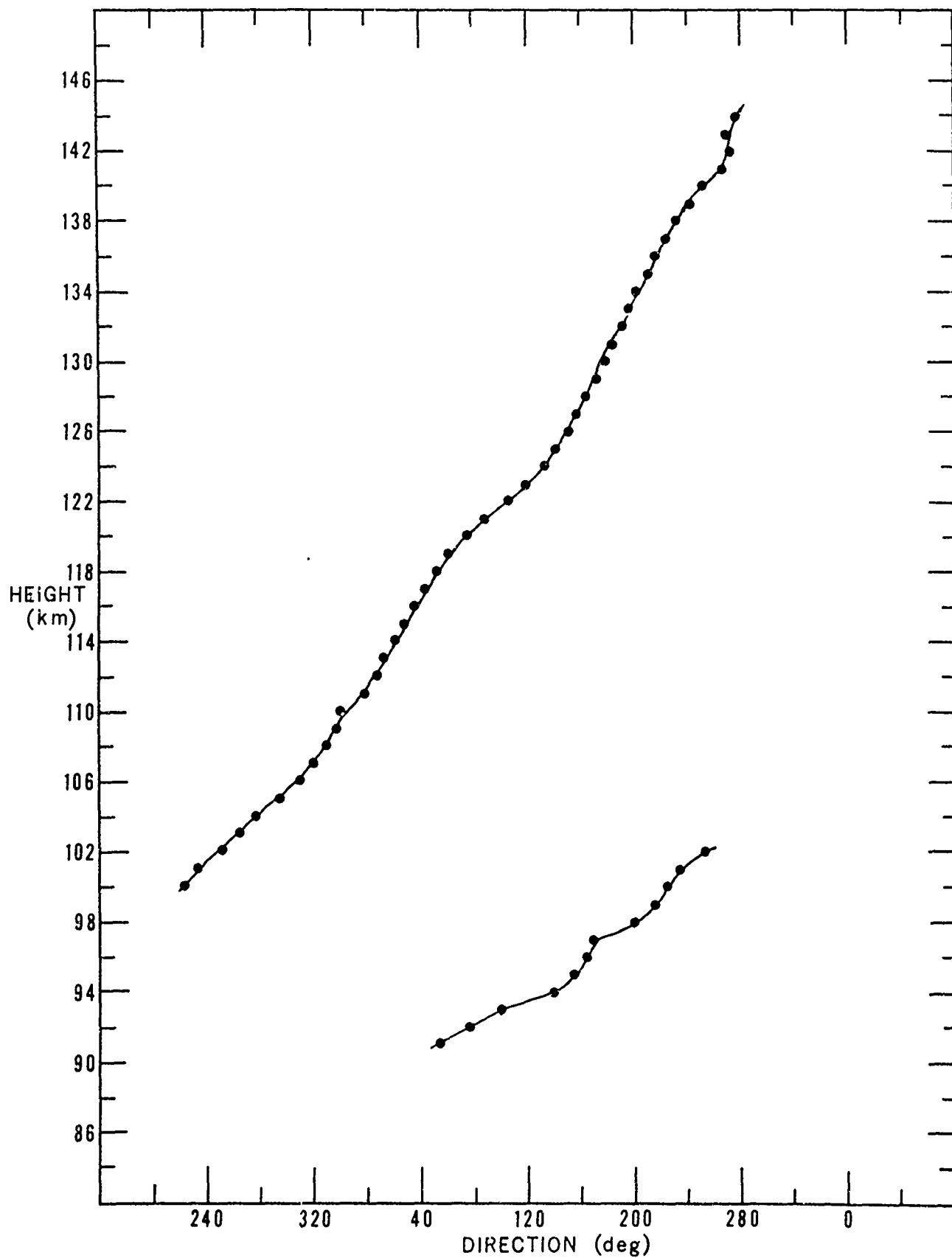
• UP

TRAIL NO. Y18

01:01:22 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

 TRAIL NO. 19  
 19 NOVEMBER 1966

02-35-35 MST

OPTICAL

ALTITUDE	DIRECTION	SPEED	GEOGRAPHIC		MAGNETIC	
(KM)	WIND (DEG)	WIND (M/S)	WIND COMPONENTS (M/S)			
			N-S	E-W	N-S	E-W
88.0	24.3	56.0	51.0	23.0	55.1	9.7
89.0	37.9	64.0	50.5	39.3	58.6	25.7
90.0	57.6	42.0	22.5	35.4	30.5	28.8
91.0	166.6	24.2	-23.5	5.6	-21.4	11.2
92.0	186.1	52.7	-52.4	-5.6	-52.2	7.5
93.0	192.4	73.7	-71.9	-15.8	-73.6	2.4
94.0	190.9	86.8	-85.2	-16.4	-86.6	5.1
95.0	190.9	104.1	-102.2	-19.8	-103.9	6.0
96.0	196.2	107.4	-103.2	-30.1	-107.4	-3.8
97.0	201.8	115.9	-107.6	-43.0	-114.9	-15.2
98.0	206.0	124.6	-112.0	-54.6	-122.0	-25.4
99.0	212.4	130.4	-110.1	-69.9	-123.9	-40.6
100.0	227.6	116.9	-78.8	-86.4	-97.6	-64.3
101.0	260.8	102.0	-16.2	-100.7	-40.5	-93.6
102.0	264.6	101.3	-9.6	-100.9	-34.1	-95.4
103.0	292.8	98.6	38.2	-90.9	14.6	-97.5
104.0	311.5	90.8	60.2	-68.0	41.6	-80.7
105.0	331.9	72.6	64.0	-34.2	53.6	-48.9
106.0	10.2	68.6	67.5	12.1	68.4	-4.9
107.0	35.8	80.2	65.1	46.9	74.6	29.4
108.0	47.9	85.5	57.4	63.4	71.2	47.3
109.0	55.1	88.1	54.5	72.3	66.7	57.6
110.0	64.8	90.3	38.4	81.7	57.3	69.7
111.0	73.1	94.0	27.3	89.9	48.6	80.4
112.0	75.4	90.0	22.7	87.1	43.4	78.8
113.0	80.6	86.7	14.1	85.5	34.7	79.4
114.0	84.7	70.9	6.5	70.6	23.7	66.8
115.0	89.2	50.8	0.7	50.8	13.2	49.1
116.0	94.2	31.1	-2.3	31.1	5.4	30.7
117.0	108.7	17.2	-5.5	16.3	-1.3	17.2
118.0	230.8	13.6	-8.6	-10.5	-10.9	-8.1
119.0	245.1	21.7	-9.1	-19.7	-13.7	-16.9
120.0	250.8	24.8	-8.2	-23.4	-13.7	-20.7

# WIND COMPONENTS

UP

N-S ○

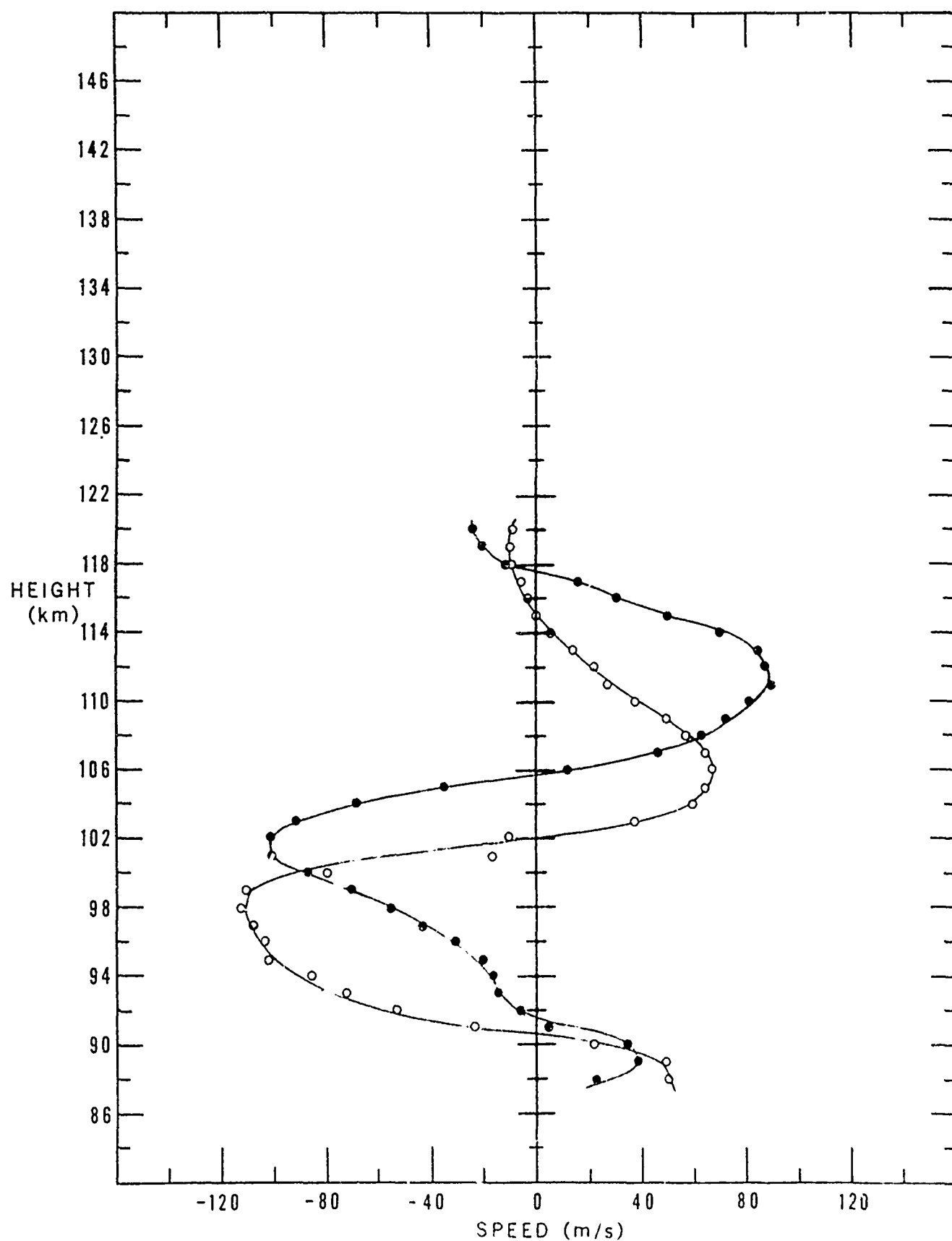
E-W ●

TRAIL NO. Y19

02:35:35 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

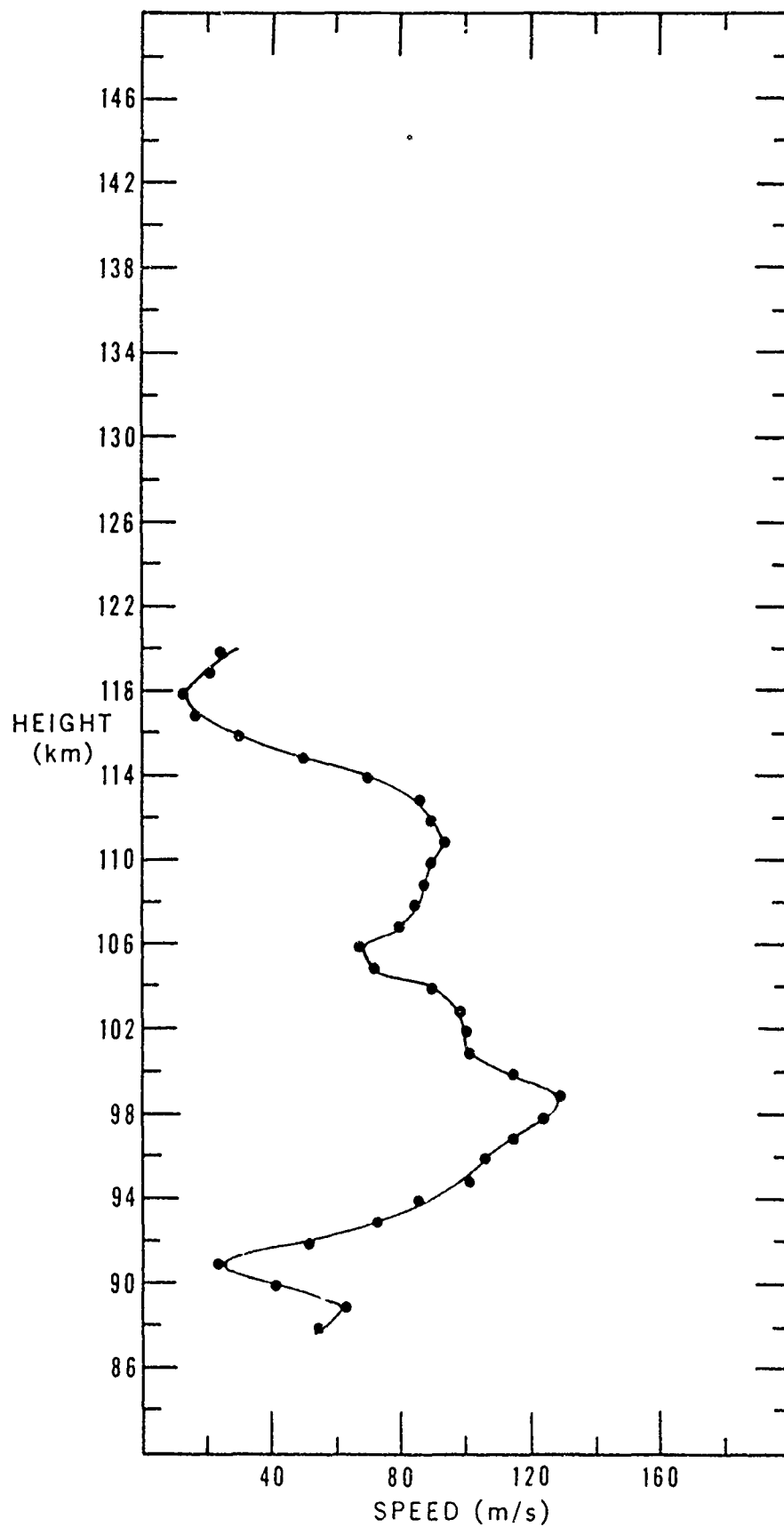
• UP

TRAIL NO. Y19

02:35:35 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

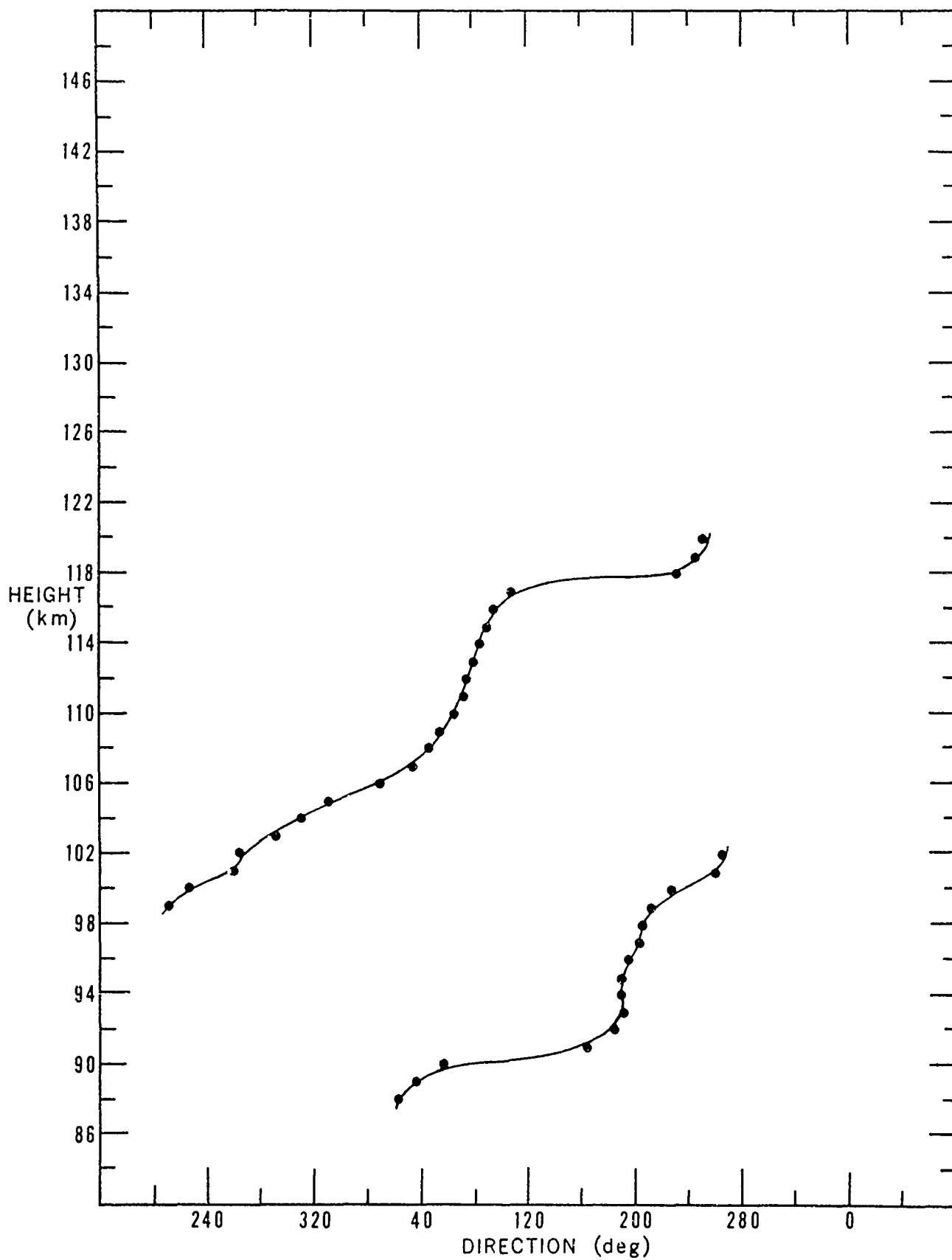
• UP

TRAIL NO. Y19

02:35:35 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y20  
19 NOVEMBER 1966

04-52-53 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
92.0	195.7	65.1	-62.7	-17.7	-65.1	-1.7
93.0	204.8	66.7	-60.6	-28.0	-65.6	-12.2
94.0	215.1	65.5	-53.6	-37.7	-61.2	-23.3
95.0	229.7	64.6	-41.7	-49.3	-52.6	-37.5
96.0	236.9	66.9	-36.6	-56.0	-49.3	-45.3
97.0	239.5	65.2	-33.1	-56.2	-45.9	-46.3
98.0	247.6	70.4	-26.8	-65.0	-42.0	-56.4
99.0	255.2	78.7	-20.0	-76.1	-38.1	-68.8
100.0	277.4	86.8	11.2	-86.1	-10.3	-86.2
101.0	291.8	98.1	36.4	-91.1	12.9	-97.3
102.0	306.4	93.1	55.3	-74.9	35.2	-86.2
103.0	324.7	77.0	62.8	-44.4	49.9	-58.5
104.0	353.8	63.3	62.9	-6.9	59.3	-22.2
105.0	34.5	70.8	58.4	40.1	66.5	24.5
106.0	49.7	71.1	46.0	54.2	57.9	41.2
107.0	56.8	70.0	38.3	58.6	51.5	47.4
108.0	68.6	56.5	20.6	52.6	32.9	45.9
109.0	79.1	46.8	8.8	46.0	19.9	42.4
110.0	90.0	37.7	0.0	37.7	9.3	36.5
111.0	101.9	28.0	-5.8	27.4	1.1	28.0
112.0	121.8	19.2	-10.1	16.3	-5.8	18.3
113.0	170.9	13.7	-13.5	2.2	-12.5	5.5
114.0	227.8	20.6	-13.8	-15.3	-17.1	-11.4
115.0	249.7	33.3	-11.6	-31.2	-18.9	-27.4
116.0	255.5	44.0	-11.0	-42.6	-21.1	-38.6
117.0	258.2	57.2	-11.7	-56.0	-25.1	-51.4
118.0	269.4	67.7	-11.3	-66.8	-27.4	-62.0
119.0	262.0	77.9	-10.9	-77.1	-29.5	-72.0
120.0	263.5	87.6	-10.0	-87.1	-31.1	-82.0
121.0	264.9	93.7	-8.3	-93.4	-31.0	-88.5
122.0	267.4	98.6	-4.5	-98.5	-28.6	-94.4
123.0	268.7	98.6	-2.3	-98.6	-26.5	-95.0
124.0	272.7	94.2	-4.4	-94.1	-18.9	-92.3
125.0	275.3	91.3	8.5	-90.9	-14.1	-90.2

CONTINUED



ALTITUDE	DIRECTION	SPEED	GEOGRAPHIC		MAGNETIC	
	WIND	WIND	WIND COMPONENTS (M/S)			
(KM)	(DEG)	(M/S)	N-S	E-W	N-S	E-W
126.0	276.7	85.3	10.0	-84.7	-11.2	-84.6
127.0	278.0	77.8	10.8	-77.0	-8.5	-77.3
128.0	277.2	69.6	8.8	-69.1	-8.5	-69.1
129.0	274.9	63.2	5.4	-63.0	-10.3	-62.4
130.0	273.3	53.5	3.1	-53.4	-10.1	-52.5
131.0	270.1	44.6	0.1	-44.6	-10.9	-43.3
132.0	265.1	34.9	-3.0	-34.7	-11.4	-32.9
133.0	254.3	22.9	-6.2	-22.1	-11.4	-19.9
134.0	226.5	13.0	-9.0	-9.4	-11.0	-6.9
135.0	165.9	12.0	-11.7	2.9	-10.6	5.7
136.0	134.7	20.6	-14.5	14.7	-10.4	17.8
137.0	125.5	30.1	-17.5	24.5	-10.9	28.1
138.0	119.8	39.2	-19.5	34.0	-10.5	37.8
139.0	117.5	47.3	-21.8	42.0	-10.8	46.1
140.0	115.5	55.1	-23.7	49.8	-10.7	54.1
141.0	113.8	62.4	-25.2	57.1	-10.4	61.5
142.0	112.8	68.7	-26.6	63.3	-10.2	67.9
143.0	109.1	80.3	-26.3	75.9	-6.8	80.0
144.0	110.1	78.5	-26.9	73.8	-7.9	78.2
145.0	110.9	82.3	-29.3	76.9	-9.5	81.7
146.0	111.5	84.6	-31.0	78.7	-10.7	83.9
147.0	113.0	86.5	-33.8	79.6	-13.2	85.5
148.0	113.7	88.1	-35.4	80.7	-14.4	86.9
149.0	114.7	89.6	-37.5	81.4	-16.3	88.1
150.0	114.3	92.3	-38.0	84.2	-16.1	91.0
151.0	117.0	92.4	-42.0	82.3	-20.4	90.1
152.0	119.2	92.0	-44.9	80.4	-23.7	89.0
153.0	121.6	91.9	-48.2	78.3	-27.4	87.8
154.0	124.2	91.6	-51.5	75.7	-31.3	86.0
155.0	126.7	90.9	-54.4	72.9	-34.8	84.0
156.0	128.7	91.4	-57.2	71.3	-37.9	83.2
157.0	130.2	92.4	-59.7	70.6	-40.5	83.1
158.0	133.0	90.6	-61.8	66.3	-43.6	79.5
159.0	135.2	88.3	-62.6	62.2	-45.4	75.7
160.0	137.3	87.8	-64.6	59.5	-48.0	73.6
161.0	139.5	87.6	-66.6	56.9	-50.5	71.5
162.0	141.9	85.1	-66.9	52.5	-51.9	67.4
163.0	143.9	86.3	-69.7	50.8	-55.1	66.4
164.0	146.8	92.9	-77.7	50.9	-62.8	68.5
165.0	148.8	96.5	-82.5	50.0	-67.7	68.8
166.0	150.9	95.5	-83.4	46.5	-69.4	65.6
167.0	152.0	95.7	-84.5	44.9	-70.8	64.3

## WIND COMPONENTS

TRAIL NO. Y20

UP

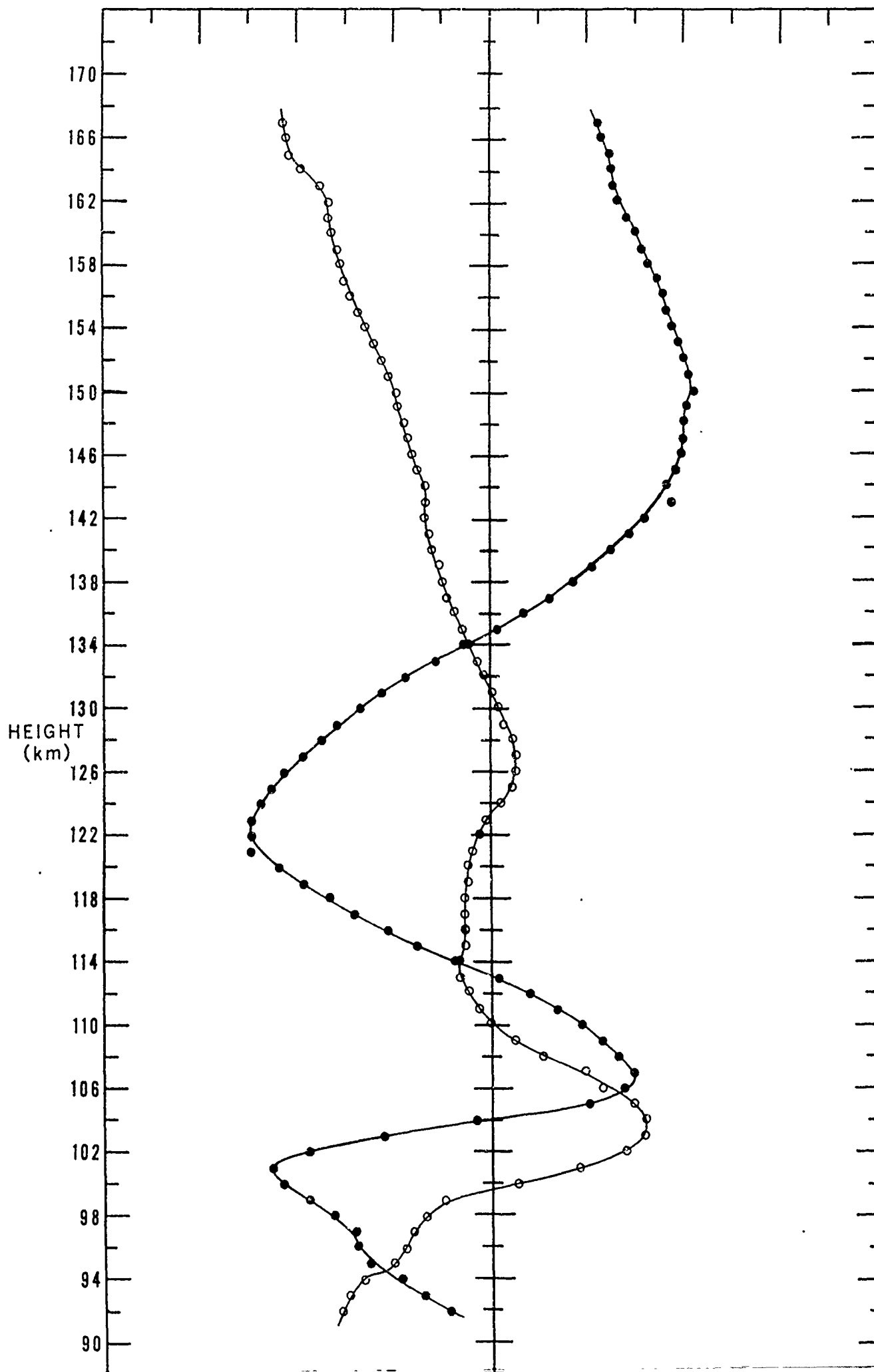
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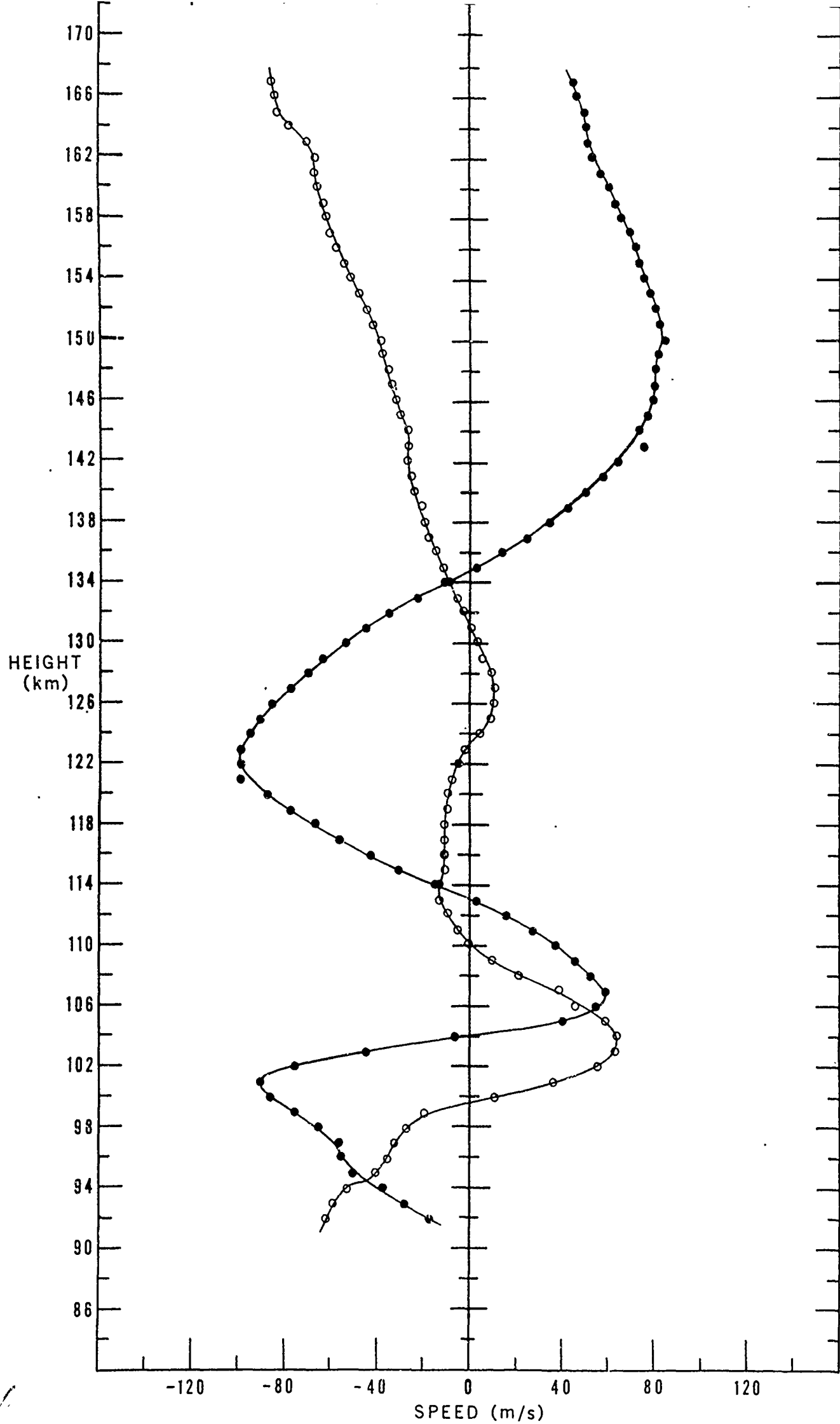
N-S ○

19 NOVEMBER 1966

E-W ●

H.A.R.P. YUMA





WIND SPEED

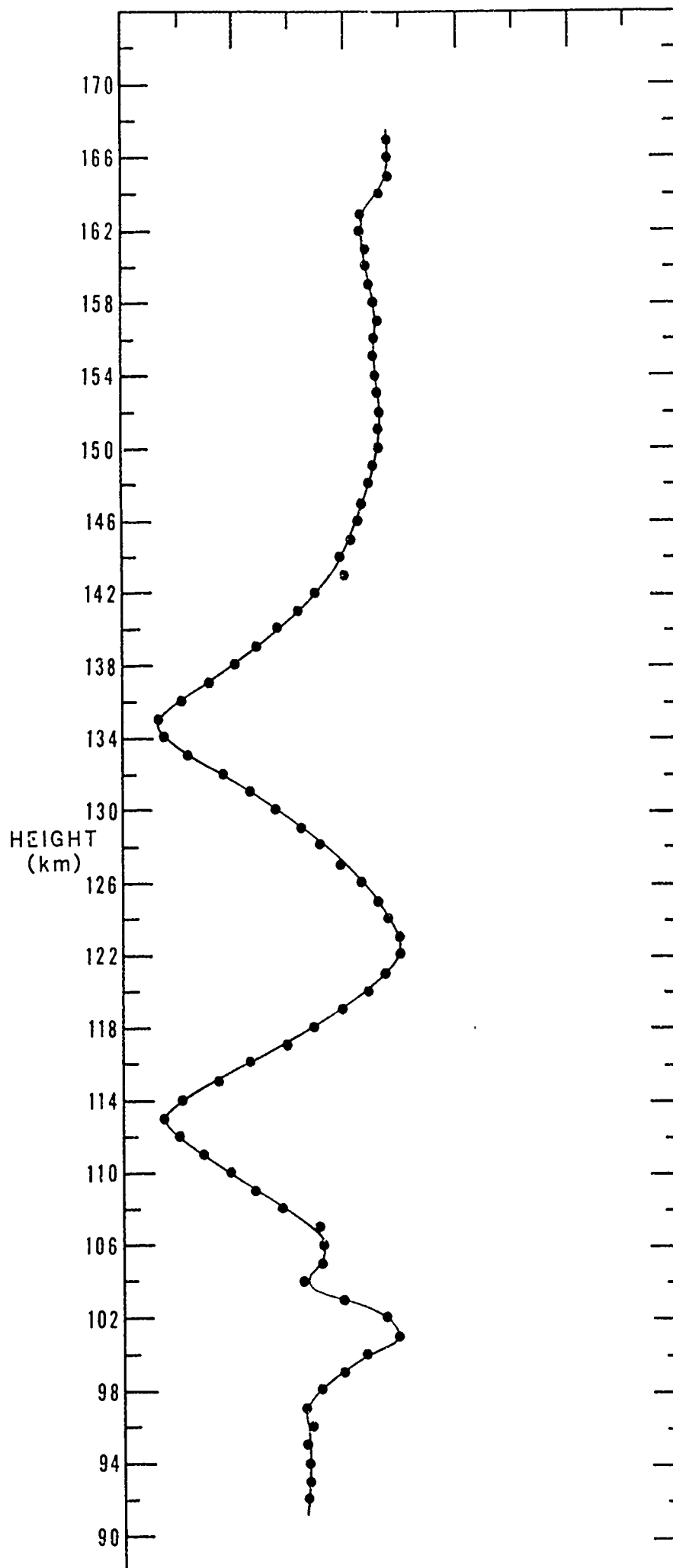
• UP

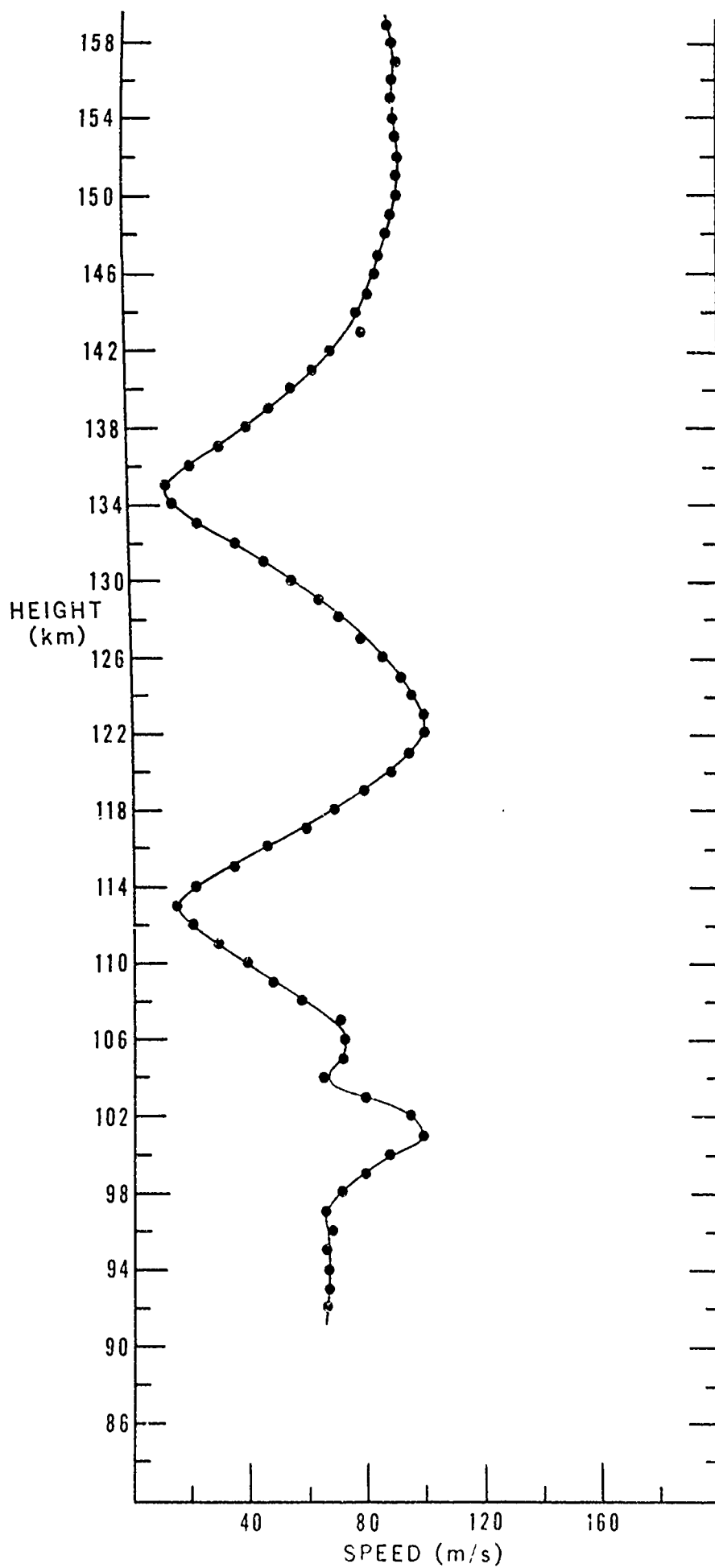
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04:52:53 MST

19 NOVEMBER 1966

H.A.R.P. YUMA





WIND DIRECTION

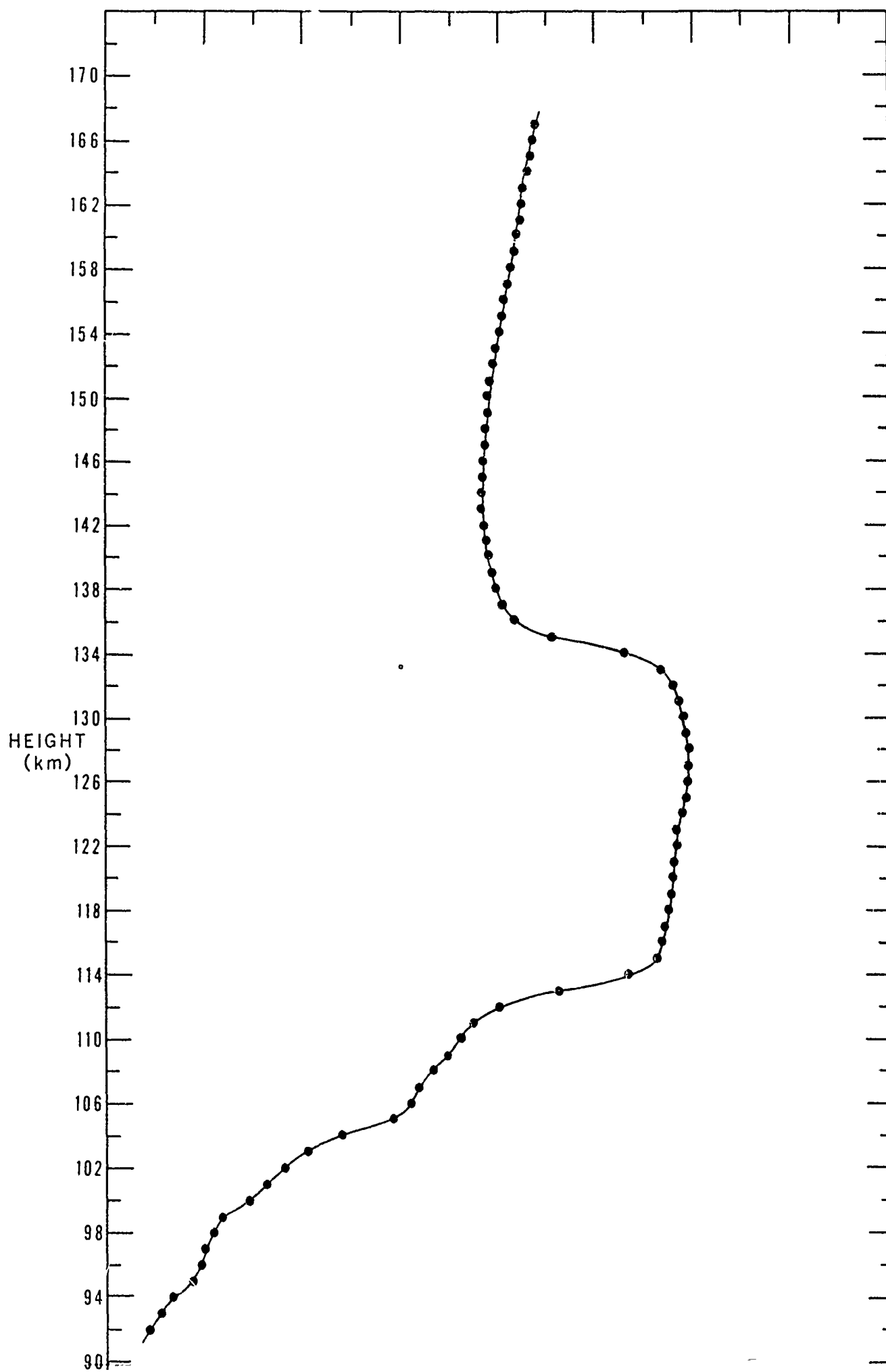
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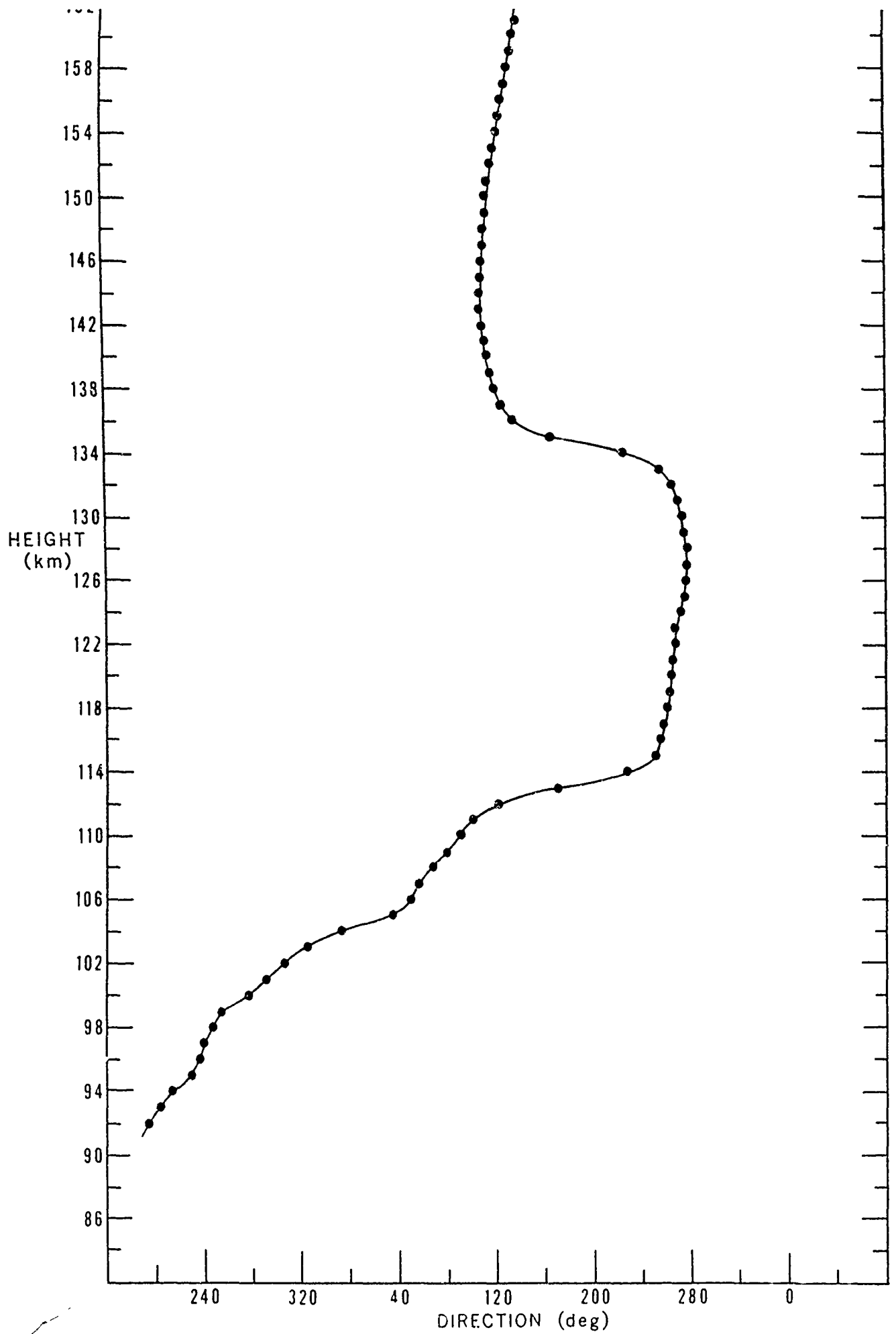
TRAIL NO. Y20

04:52:53 MST

19 NOVEMBER 1966

H.A.R.P. YUMA





YUMA

 TRAIL NO. Y21  
 19 NOVEMBER 1966

19-45-00 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
93.0	291.4	49.1	17.9	-45.8	6.1	-48.8
94.0	326.8	33.5	28.0	-18.3	22.6	-24.6
95.0	8.7	25.7	25.4	3.9	25.6	-2.5
96.0	59.9	37.2	18.7	32.2	26.1	26.6
97.0	70.6	42.1	14.0	39.7	23.3	35.0
98.0	88.9	50.9	1.0	50.9	13.5	49.1
99.0	105.1	38.1	-9.9	36.8	-0.5	38.1
100.0	117.6	20.9	-9.7	18.6	-4.8	20.4
101.0	78.6	2.0	0.4	2.0	0.9	1.8
102.0	347.6	21.0	20.6	-4.5	18.9	-9.4
103.0	349.9	39.5	38.9	-6.9	36.0	-16.3
104.0	353.5	34.7	34.5	-3.9	32.5	-12.3
105.0	330.5	31.5	27.4	-15.5	22.7	-21.8
106.0	285.9	30.9	8.5	-29.8	0.9	-31.0
107.0	247.8	55.3	-20.9	-51.2	-32.9	-44.5
108.0	239.8	75.9	-38.2	-65.5	-53.1	-54.1
109.0	238.0	105.5	-55.9	-89.4	-76.2	-72.9
110.0	238.6	121.8	-63.5	-103.9	-87.1	-85.1
111.0	240.4	133.3	-65.9	-115.8	-92.4	-96.0
112.0	243.5	139.7	-62.2	-125.1	-91.1	-105.9
113.0	248.4	141.7	-52.1	-131.8	-82.9	-114.9
114.0	256.1	136.3	-32.8	-132.3	-64.4	-120.2
115.0	262.1	133.5	-18.3	-132.2	-50.3	-123.6
116.0	266.4	131.3	-8.2	-131.0	-40.2	-125.0
117.0	269.9	119.3	-0.2	-119.3	-29.6	-115.6
118.0	272.1	114.4	4.3	-114.3	-24.0	-111.8
119.0	274.6	103.5	8.3	-103.1	-17.3	-102.0
120.0	276.8	91.5	10.8	-90.9	-11.9	-90.8
121.0	276.9	84.5	10.1	-83.8	-10.8	-83.7
122.0	280.4	68.2	12.3	-67.1	-4.6	-68.1
123.0	281.7	56.5	11.4	-55.3	-2.6	-56.4
124.0	283.6	44.0	10.4	-42.8	-0.5	-44.0
125.0	288.4	30.3	9.5	-28.8	2.1	-30.3
126.0	334.5	7.7	6.9	-3.3	5.9	-4.9
127.0	59.6	9.6	4.8	8.2	6.7	6.8

CONTINUED



ALTITUDE	DIRECTION	SPEED	GEOGRAPHIC		MAGNETIC	
	WIND	WIND	WIND COMPONENTS (M/S)			
(KM)	(DEG)	(M/S)	N-S	E-W	N-S	E-W
128.0	82.0	20.9	2.9	20.7	7.9	19.3
129.0	90.0	32.3	0.0	32.3	8.0	31.3
130.0	95.2	46.3	-4.2	46.1	7.3	45.7
131.0	95.8	54.0	-5.5	53.8	7.9	53.5
132.0	97.1	63.7	-7.9	63.2	7.9	63.2
133.0	100.0	70.3	-12.2	69.3	5.2	70.2
134.0	101.9	80.1	-16.5	78.3	3.3	80.0
135.0	103.6	87.7	-20.6	85.3	1.0	87.7
136.0	105.1	88.9	-23.2	85.8	-1.4	88.9
137.0	106.4	91.0	-25.8	87.3	-3.5	91.0
138.0	107.7	91.6	-27.8	87.3	-5.5	91.5
139.0	104.9	88.4	-22.7	85.4	-1.0	88.4
140.0	106.3	86.9	-24.4	83.4	-3.1	86.8
141.0	105.1	86.3	-22.4	83.3	-1.2	86.3
142.0	104.8	79.0	-20.3	76.3	-0.9	78.9

# WIND COMPONENTS

UP

N-S ○

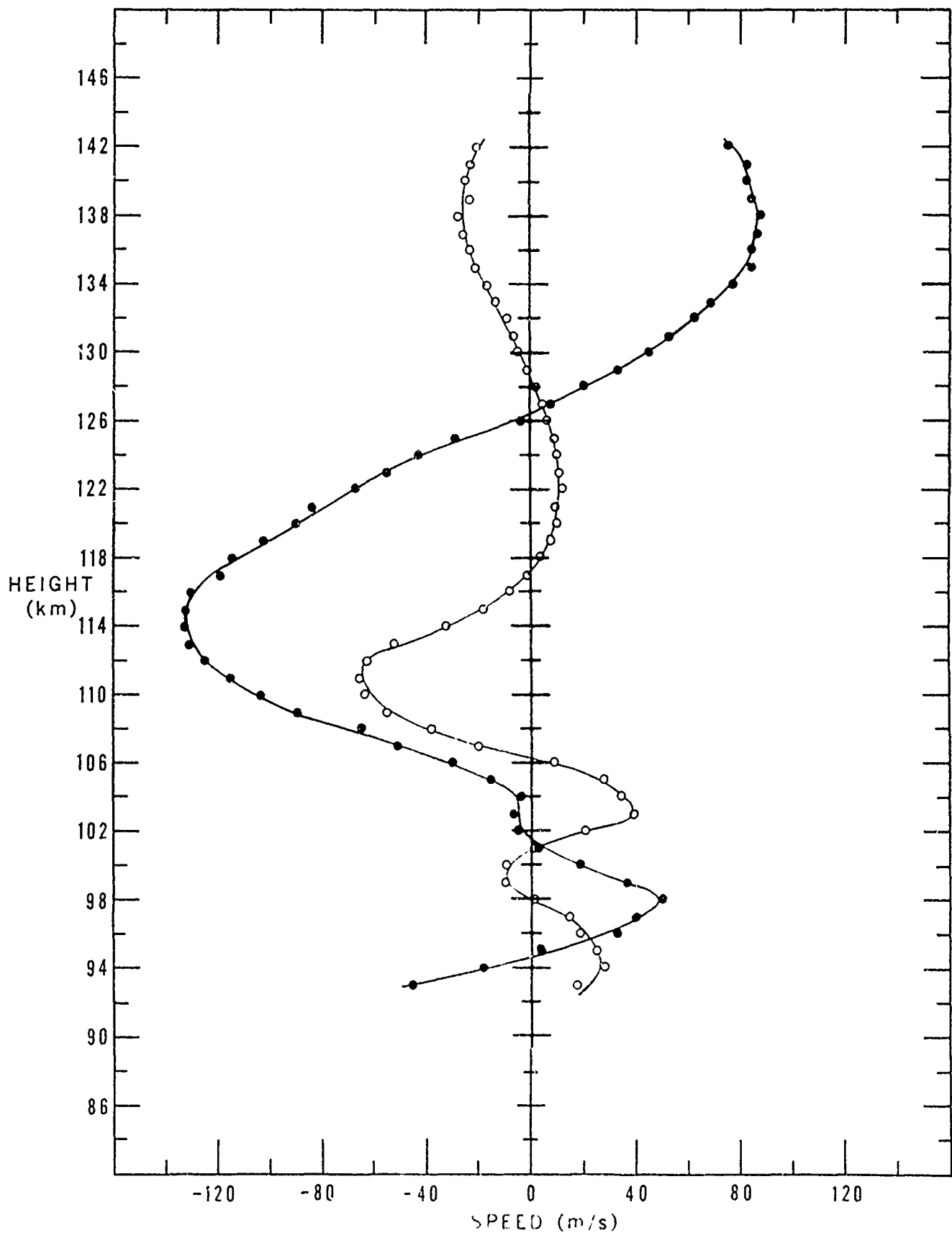
E-W ●

TRAIL NO. Y21

19:45:00 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

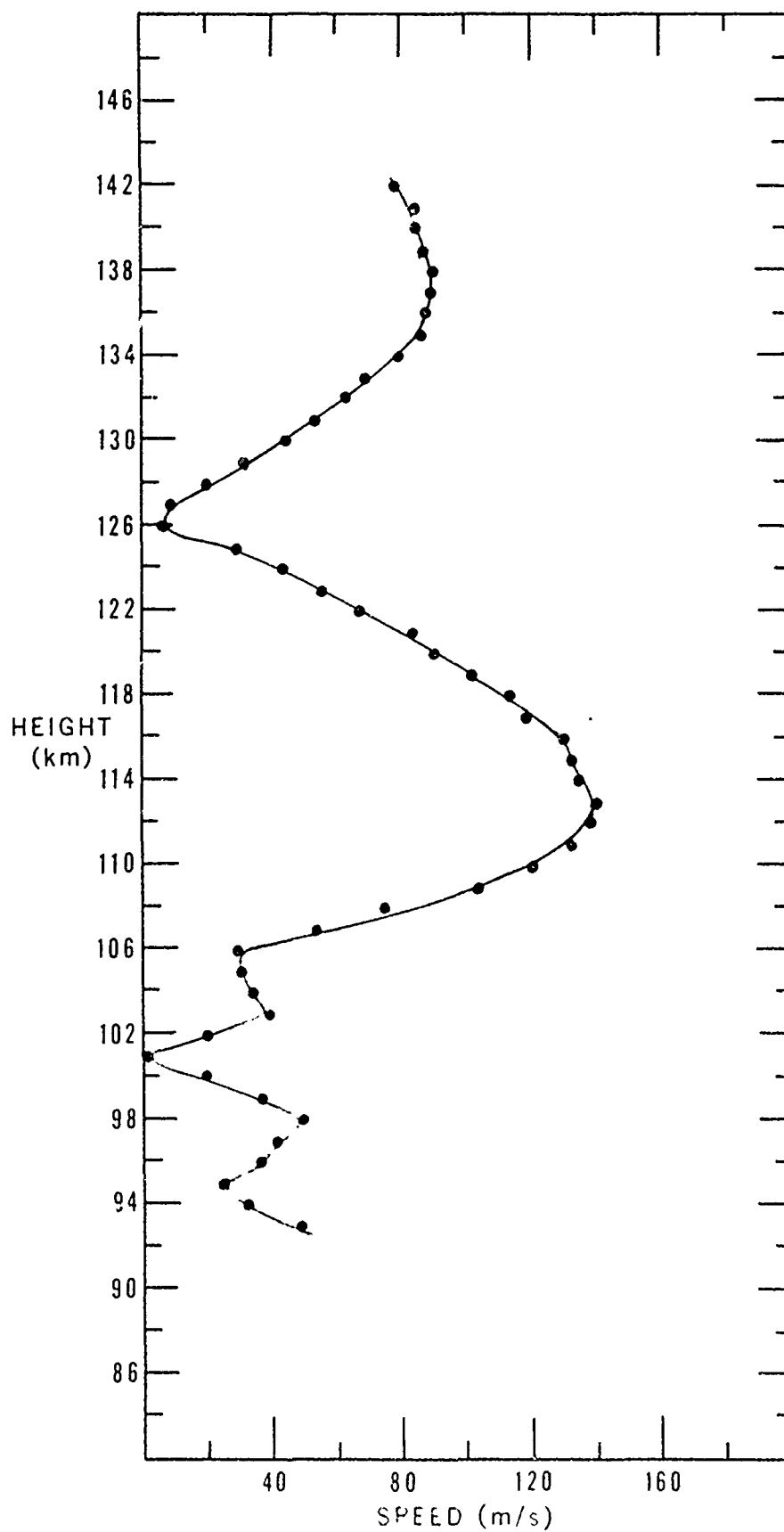
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TRAIL NO. Y21

19:45:00 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

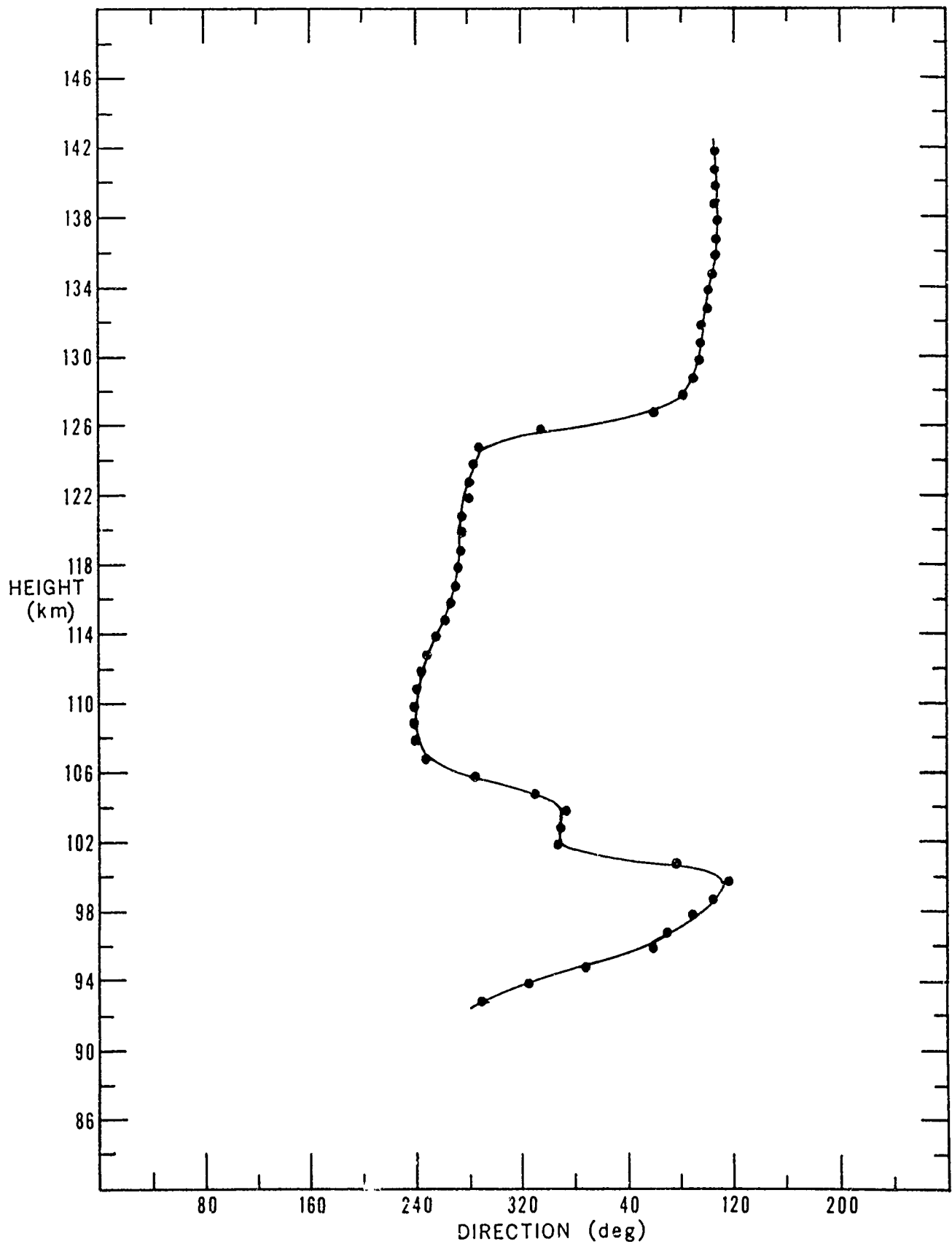
• UP

TRAIL NO. Y21

19:45:00 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y22  
19 NOVEMBER 1966

21-21-29 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
91.0	289.8	52.0	17.6	-49.0	5.0	-51.8
92.0	300.7	54.4	27.8	-46.7	15.4	-52.1
93.0	345.7	39.7	38.4	-9.8	34.8	-19.0
94.0	1.5	36.1	36.1	0.9	35.2	-8.0
95.0	51.4	37.4	23.3	29.2	29.8	22.6
96.0	76.8	42.1	9.6	40.9	19.4	37.3
97.0	97.6	35.8	-4.7	35.5	4.2	35.6
98.0	124.9	25.4	-14.5	20.9	-8.9	23.8
99.0	140.8	21.5	-16.7	13.6	-12.8	17.3
100.0	178.1	10.1	-10.1	0.3	-9.7	2.8
101.0	319.4	20.5	15.6	-13.3	11.8	-16.7
102.0	339.5	35.8	33.5	-12.5	29.4	-20.4
103.0	336.0	31.3	28.6	-12.7	24.6	-19.3
104.0	298.7	39.4	19.0	-34.6	9.9	-38.2
105.0	276.1	57.7	6.2	-57.4	-8.1	-57.2
106.0	258.2	107.0	-21.8	-104.7	-46.9	-96.1
107.0	250.9	143.4	-46.9	-135.5	-78.8	-119.8
108.0	251.9	162.9	-50.7	-154.8	-87.2	-137.6
109.0	261.3	169.2	-25.6	-167.2	-66.0	-155.8

## DOWNTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
99.0	140.3	28.0	-21.5	17.9	-16.4	22.6
100.0	162.2	3.0	-2.9	0.9	-2.6	1.6
101.0	346.0	9.3	9.0	-2.2	8.2	-4.3
102.0	2.1	21.5	21.5	0.8	21.0	-4.5
103.0	335.7	39.3	35.8	-16.2	30.7	-24.5
104.0	305.4	41.7	24.2	-34.0	15.1	-38.9
105.0	275.8	60.7	6.1	-60.4	-9.0	-60.0
106.0	257.2	113.3	-25.1	-110.5	-51.5	-100.9
107.0	254.9	141.3	-36.8	-136.4	-69.2	-123.1
108.0	254.7	149.8	-39.6	-144.5	-74.0	-130.3
109.0	264.1	151.6	-15.5	-150.8	-52.1	-142.3
110.0	272.7	148.0	1.1	-147.9	-29.5	-147.1
111.0	282.0	145.3	30.1	-142.2	-5.8	-145.2

# WIND COMPONENTS

UP DOWN

N-S ○ △

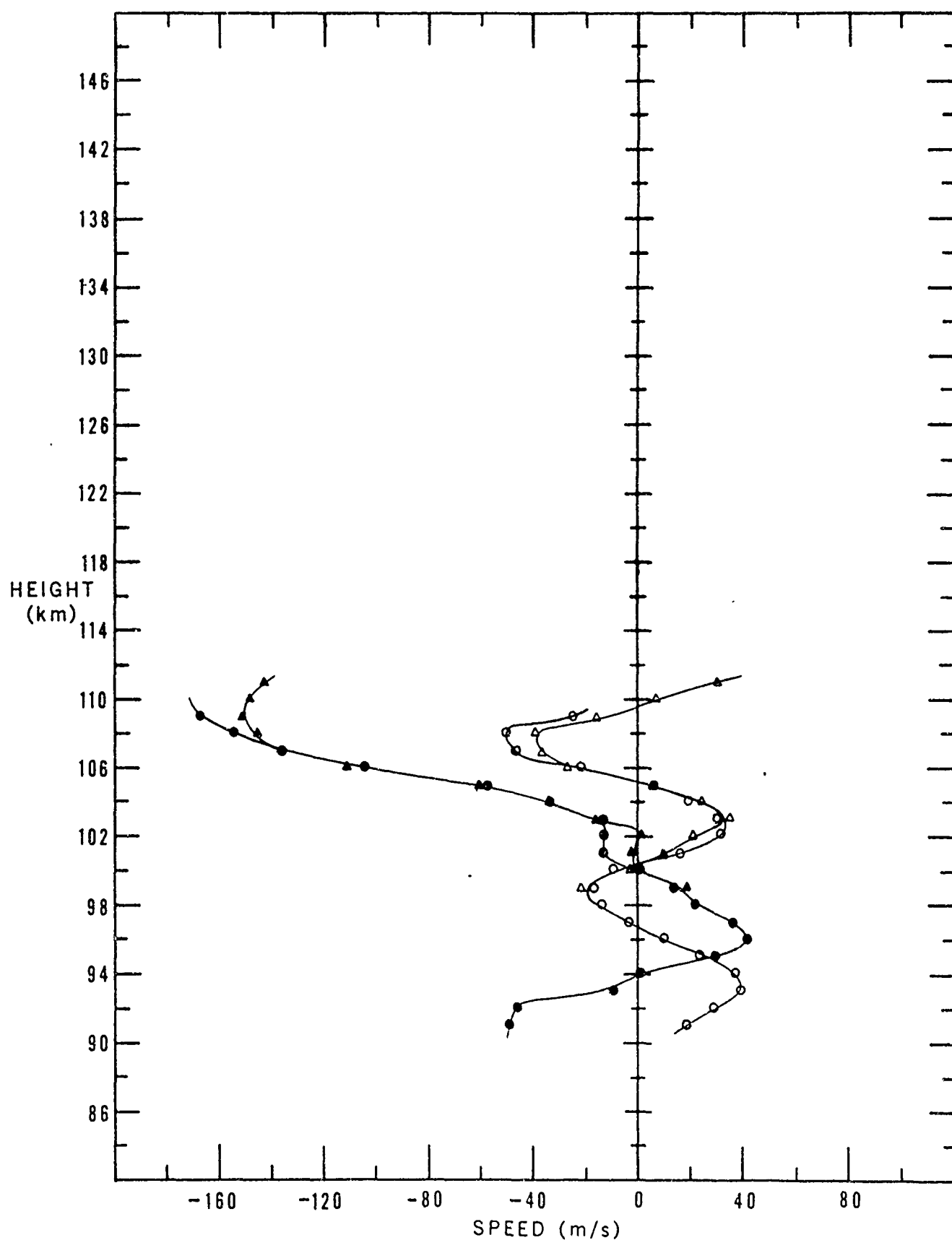
E-W ● ▲

TRAIL NO. Y22

21:21:29 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

• UP

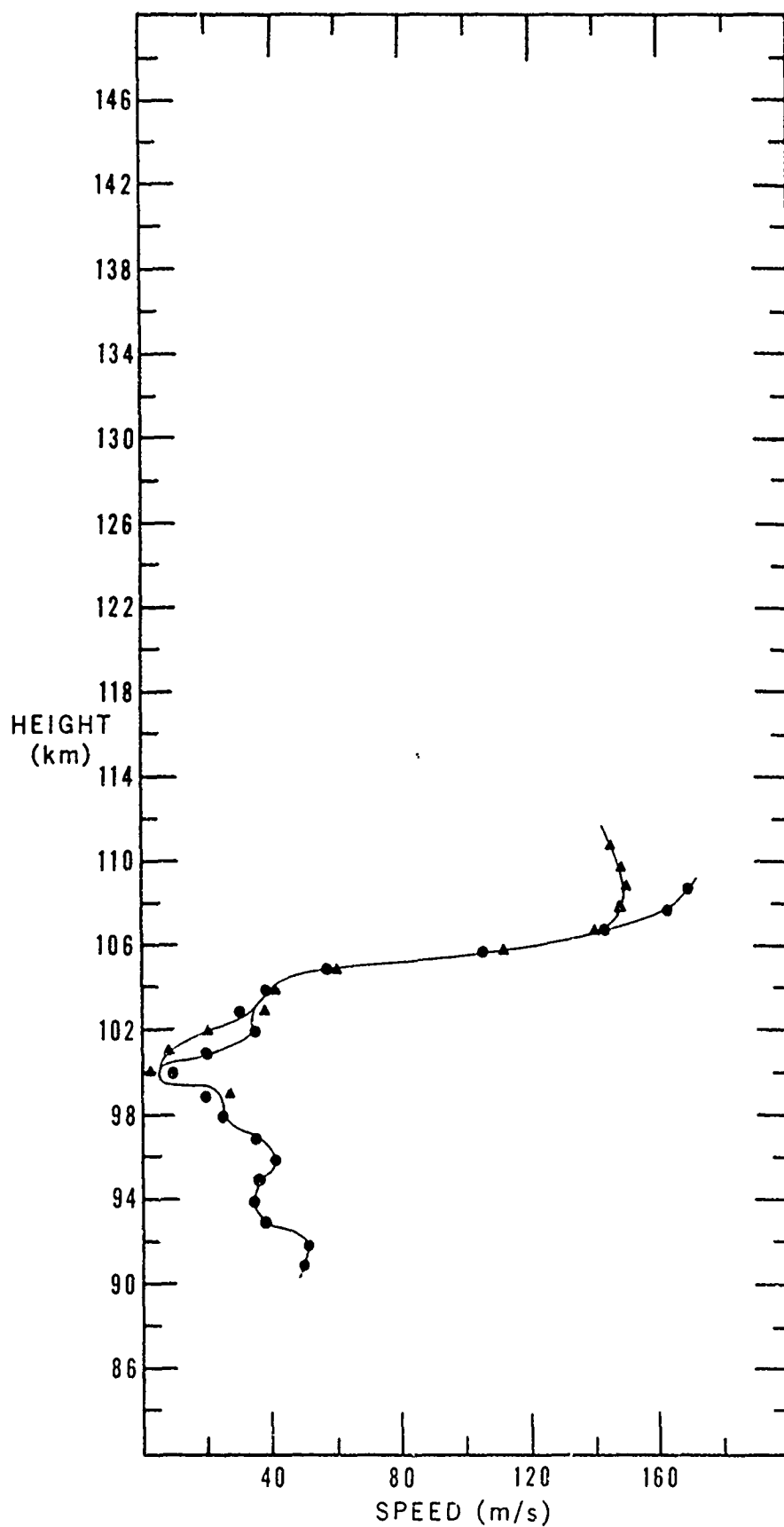
▲ DOWN

TRAIL NO. Y22

21:21:29 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

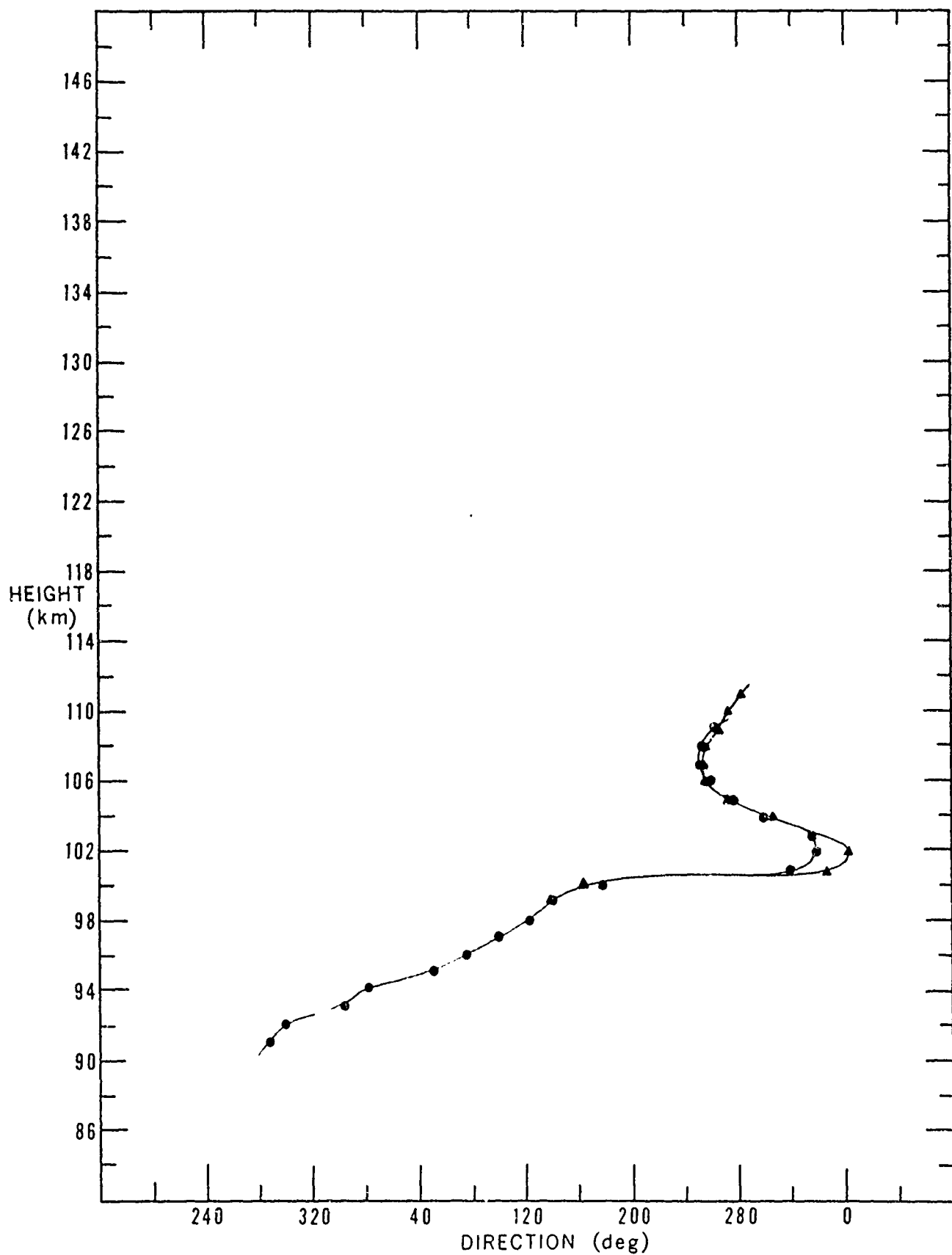
- UP
- ▲ DOWN

TRAIL NO. Y22

21:21:29 MST

19 NOVEMBER 1966

H.A.R.P. YUMA





YUMA

TRAIL NO. Y23  
19 NOVEMBER 1966

22-37-53 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
90.0	326.0	44.8	37.5	-24.5	30.3	-33.0
91.0	327.1	44.4	37.5	-23.7	30.5	-32.2
92.0	348.7	53.1	52.0	-10.4	47.8	-22.9
93.0	31.1	43.9	37.6	22.7	42.0	12.7
94.0	54.5	48.1	28.0	39.2	36.8	31.1
95.0	74.0	55.3	15.2	53.1	27.8	47.7
96.0	84.0	54.7	5.7	54.4	18.9	51.3
97.0	93.5	41.9	-2.6	41.8	7.8	41.2
98.0	50.0	7.8	5.0	6.0	6.3	4.6
99.0	318.0	43.9	32.6	-29.4	24.4	-36.5
100.0	315.2	55.7	39.5	-39.3	28.6	-47.8
101.0	324.2	86.3	70.0	-50.5	55.4	-66.2
102.0	331.2	97.7	85.6	-47.0	71.4	-66.6
103.0	327.0	87.0	73.0	-47.3	59.1	-63.8
104.0	287.1	84.9	25.0	-81.1	4.3	-84.8
105.0	271.2	116.1	2.5	-116.1	-26.2	-113.1
106.0	266.7	148.5	-8.4	-148.3	-44.6	-141.7
107.0	269.4	166.3	-1.7	-166.3	-42.6	-160.8
108.0	275.6	166.5	16.2	-165.7	-25.1	-164.6
109.0	279.2	167.0	26.7	-164.8	-14.1	-166.3
110.0	281.7	172.6	35.1	-169.0	-7.6	-172.4
111.0	283.3	185.4	42.7	-180.4	-3.0	-185.4

# WIND COMPONENTS

UP

N-S ○

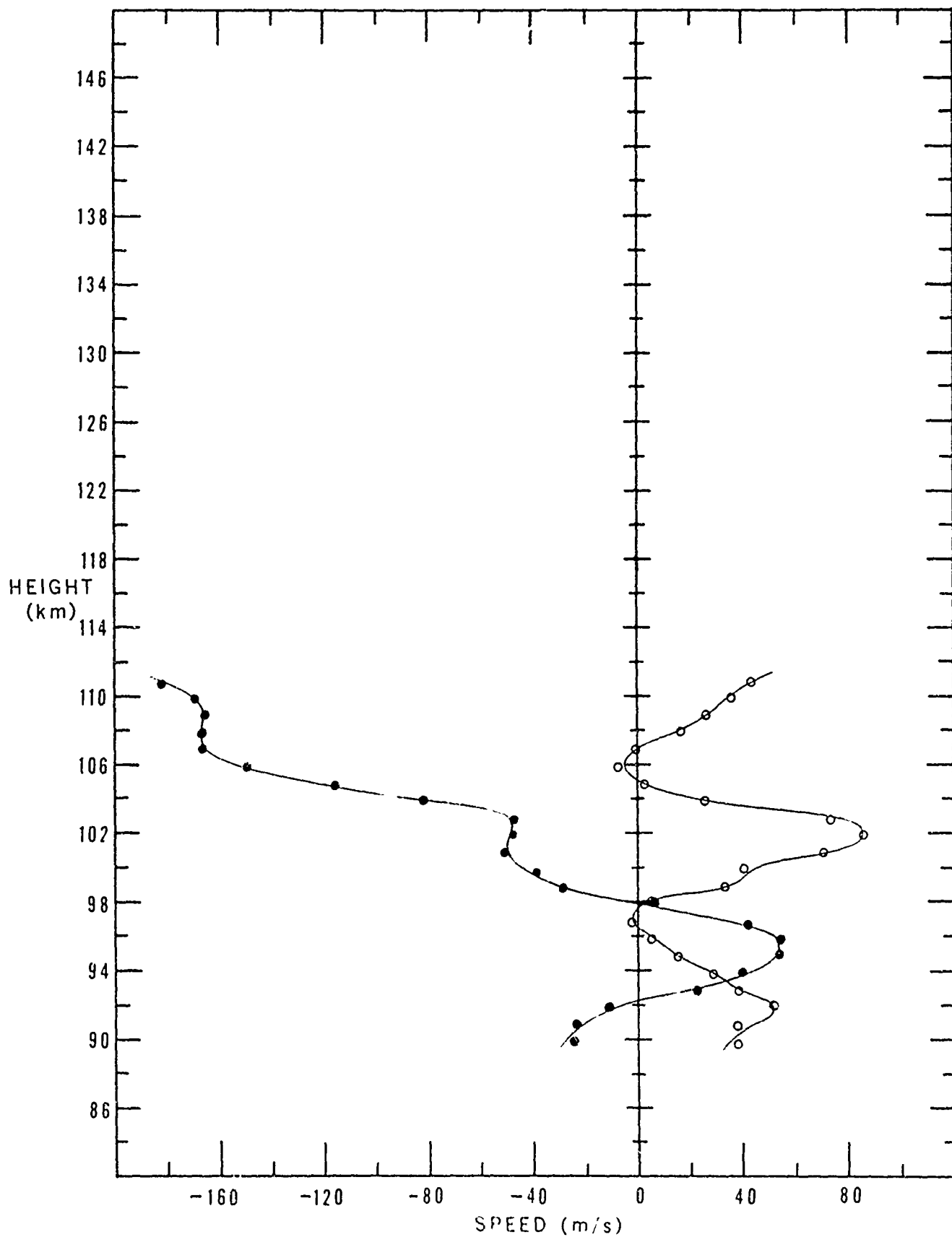
E-W ●

TRAIL NO. Y23

22:37:53 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND SPEED

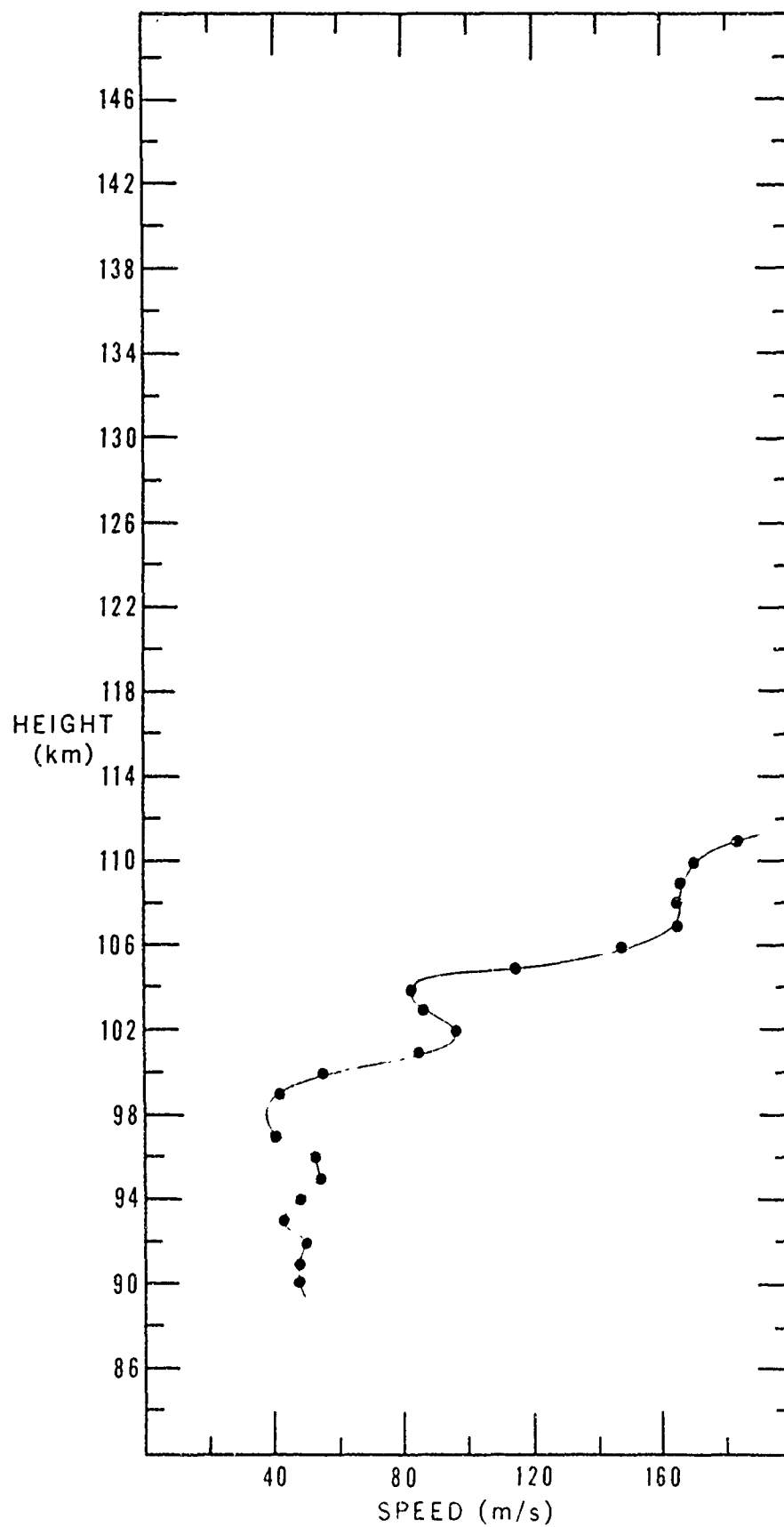
• UP

TRAIL NO. Y23

22:37:53 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



WIND DIRECTION

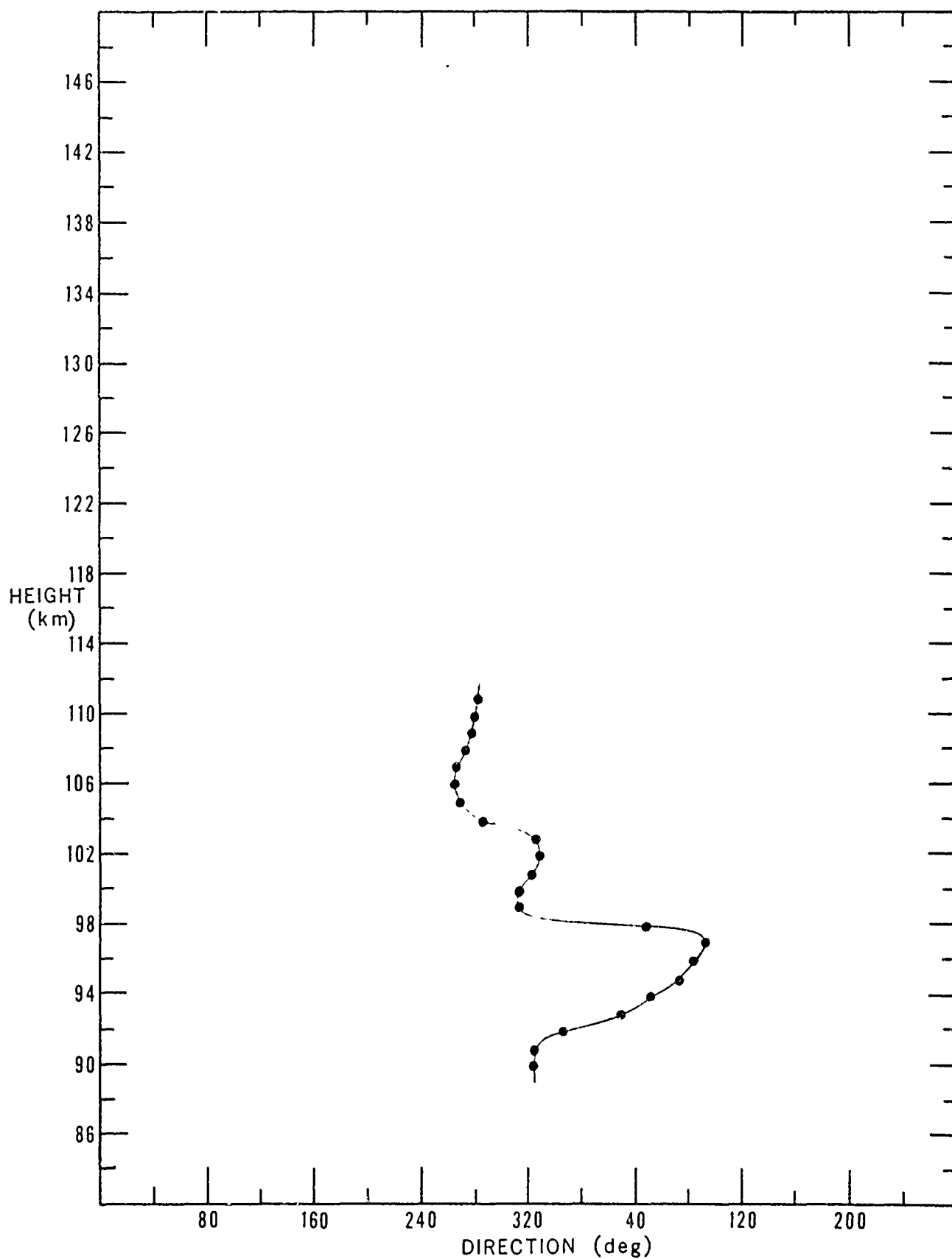
• 1-P

TRAIL NO. Y23

22.37:53 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



YUMA

TRAIL NO. Y24  
19 NOVEMBER 1966

23-59-14 MST

## UPTRAIL

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
91.0	4.4	57.6	57.5	4.4	56.8	-9.9
92.0	27.7	39.9	35.4	18.6	38.9	9.3
93.0	42.1	37.2	27.6	25.0	32.9	17.4
94.0	72.2	22.1	6.7	21.0	11.7	18.7
95.0	209.4	22.4	-19.5	-11.0	-21.6	-5.9
96.0	219.2	34.9	-27.1	-22.0	-31.7	-14.7
97.0	234.3	33.7	-19.7	-27.3	-25.8	-21.6
98.0	274.6	39.6	3.2	-39.4	-6.6	-39.0
99.0	291.0	47.2	17.0	-44.1	5.6	-46.9
100.0	311.8	55.4	36.9	-41.3	25.6	-49.1
101.0	346.4	62.6	60.9	-14.7	55.4	-29.2
102.0	343.3	42.0	40.3	-12.1	36.1	-21.6
103.0	266.5	50.3	-3.1	-50.2	-15.4	-47.9
104.0	258.3	68.7	-13.9	-67.3	-30.0	-61.8
105.0	256.9	82.7	-18.8	-80.5	-38.0	-73.4
106.0	257.1	91.6	-20.5	-89.2	-41.8	-81.4
107.0	253.8	107.4	-29.9	-103.1	-54.4	-92.6
108.0	262.3	133.3	-17.8	-132.1	-49.8	-123.7
109.0	270.4	125.5	0.9	-125.5	-30.0	-121.9
110.0	277.2	119.8	15.0	-118.9	-14.7	-118.9
111.0	290.2	100.3	34.7	-94.1	10.5	-99.7
112.0	309.0	80.2	50.5	-62.3	33.0	-72.8
113.0	331.0	71.3	62.4	-34.5	52.0	-48.8
114.0	340.5	72.5	68.4	-24.2	60.3	-40.3
115.0	353.0	70.8	70.3	-8.6	66.0	-25.6
116.0	5.7	64.0	63.7	6.4	63.3	-9.5
117.0	46.4	56.2	38.8	40.7	47.6	29.9
118.0	70.3	65.7	22.2	61.8	36.7	54.4
119.0	74.1	72.8	20.0	70.0	36.6	62.9
120.0	93.9	86.9	-6.0	86.7	15.5	85.5
121.0	101.3	89.3	-17.5	87.5	4.6	89.1
122.0	105.2	93.3	-24.4	90.0	-1.5	93.2
123.0	109.9	95.6	-32.5	90.0	-9.3	95.2
124.0	114.8	96.9	-40.7	88.0	-17.8	95.3
125.0	119.7	98.6	-48.9	85.7	-26.3	95.1

CONTINUED

ALTITUDE (KM)	DIRECTION WIND (DEG)	SPEED WIND (M/S)	GEOGRAPHIC WIND COMPONENTS (M/S)		MAGNETIC WIND COMPONENTS (M/S)	
			N-S	E-W	N-S	E-W
126.0	124.2	100.1	-56.3	82.8	-34.2	94.1
127.0	128.5	101.3	-63.1	79.2	-41.7	92.3
128.0	132.6	102.3	-69.2	75.3	-48.5	90.0
129.0	135.7	102.1	-73.1	71.3	-53.3	87.1
130.0	138.6	103.4	-77.6	68.3	-58.4	85.3
131.0	141.9	103.7	-81.7	64.0	-63.4	82.1
132.0	145.2	103.7	-85.2	59.1	-68.0	78.3
133.0	147.1	102.1	-85.6	55.5	-69.3	74.9
134.0	150.0	100.3	-86.8	50.2	-71.8	70.0
135.0	152.0	99.3	-87.7	46.6	-73.5	66.8
136.0	153.9	98.2	-88.2	43.2	-74.9	63.6
137.0	155.8	96.9	-88.3	39.7	-75.8	60.2
138.0	157.6	95.8	-88.6	36.5	-76.9	57.2
139.0	159.4	94.2	-88.2	33.1	-77.3	53.8
140.0	161.7	90.4	-85.8	28.4	-76.2	48.6
141.0	162.7	89.4	-85.4	26.6	-76.2	46.8
142.0	164.6	78.3	-75.5	20.8	-68.1	38.7
143.0	165.4	75.6	-73.2	19.1	-66.2	36.5
144.0	166.1	71.7	-69.6	17.2	-63.2	33.8
145.0	166.8	67.7	-65.5	15.4	-59.7	31.0
146.0	166.7	63.2	-61.5	14.5	-56.0	29.2
147.0	166.2	60.1	-58.3	14.3	-53.0	28.2

# WIND COMPONENTS

UP

N-S ○

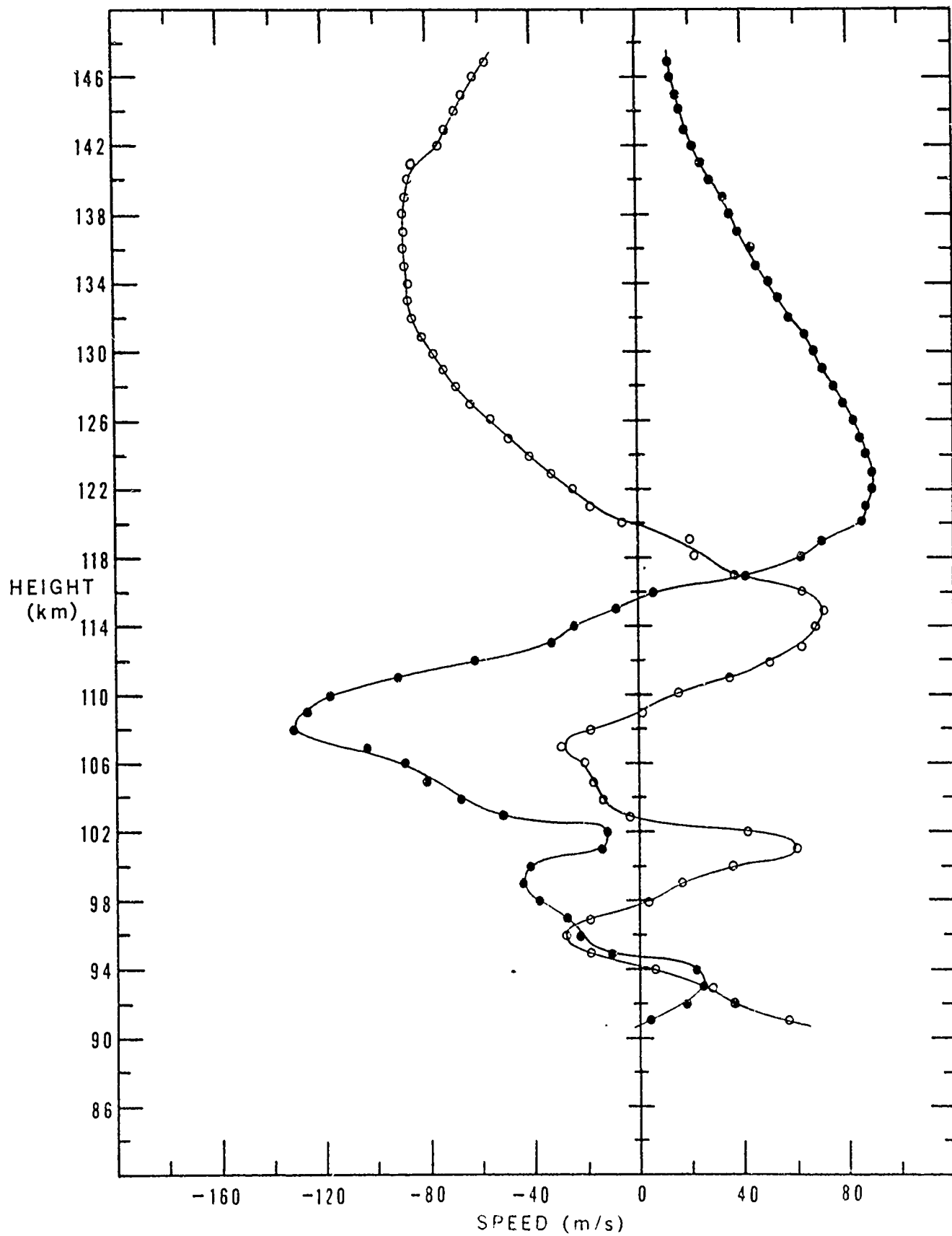
E-W ●

TRAIL NO. Y24

23:59:14 MST

19 NOVEMBER 1966

H.A.R.P., YUMA



WIND SPEED

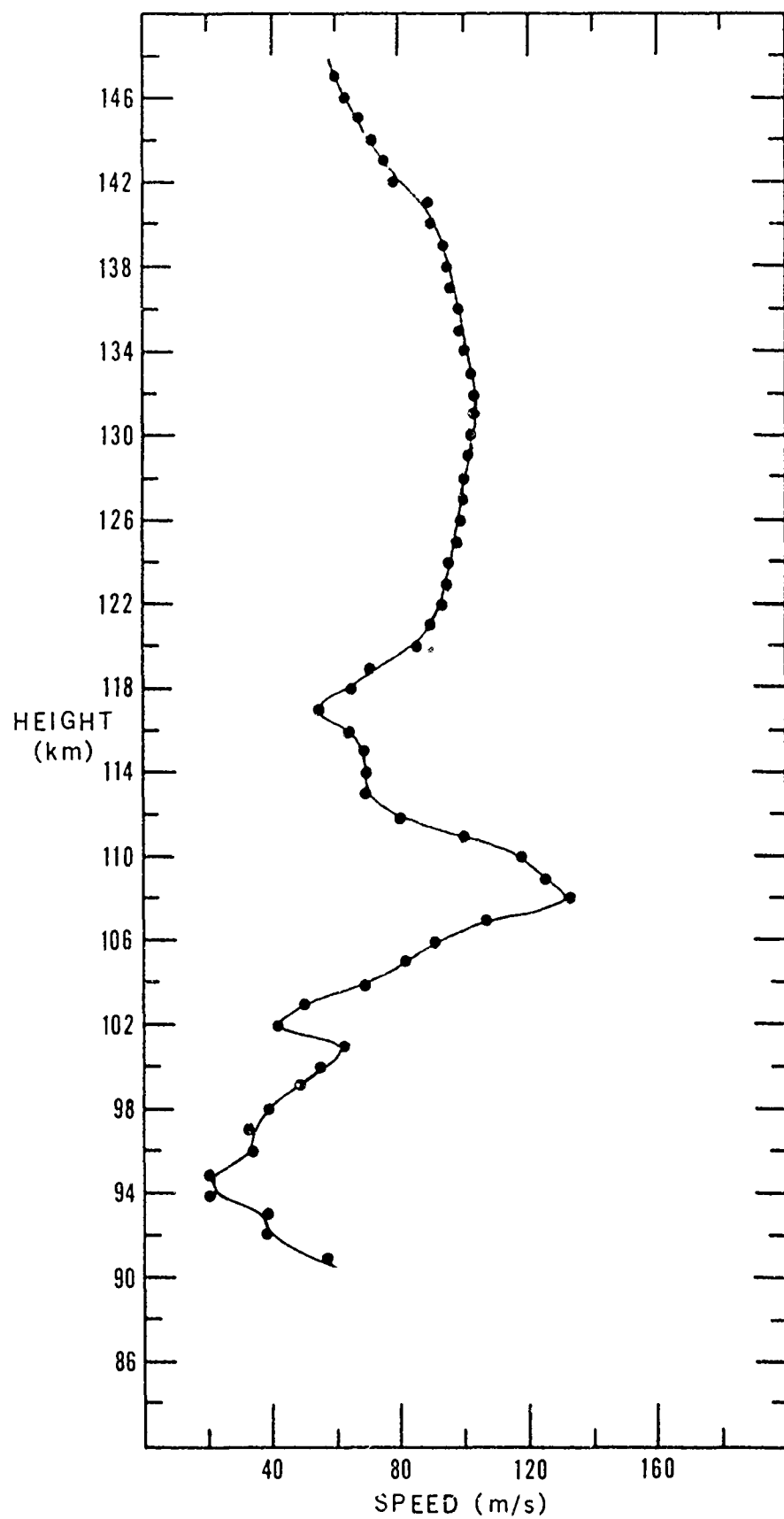
• UP

TRAIL NO. Y24

23:59:14 MST

19 NOVEMBER 1966

H.A.R.P. YUMA





WIND DIRECTION

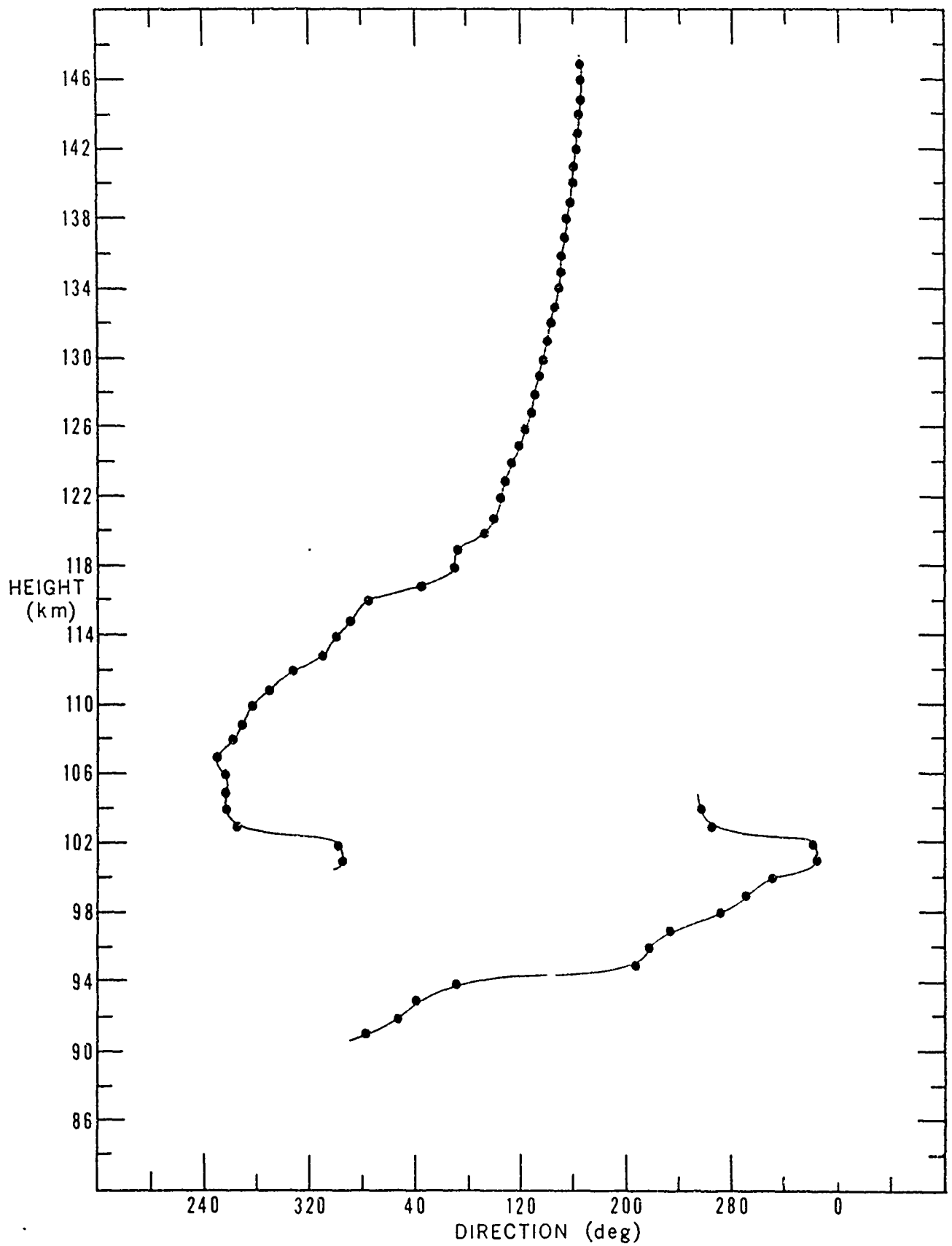
• UP

TRAIL NO. Y24

23:59:14 MST

19 NOVEMBER 1966

H.A.R.P. YUMA



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Security Classification

## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Space Instruments Research, Inc.  
Atlanta, Georgia

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

3. REPORT TITLE

UPPER ATMOSPHERE WINDS FROM GUN-LAUNCHED VERTICAL PROBES (YUMA,  
16-19 NOVEMBER 1966)

4. DESCRIPTIVE NOTES (Type of report or inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Robert L. Fuller

6. REPORT DATE

June 1967

7a. TOTAL NO. OF PAGES

85

7b. NO. OF REFS

37

8a. CONTRACT OR GRANT NO. DA-01-009-AMC-169(A)

9a. ORIGINATOR'S REPORT NUMBER(S)

b. PROJECT NO. RDTE 1V014501053C

BRL Contract 169 Report 6

c.

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned  
this report)

d.

10. DISTRIBUTION STATEMENT

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distribution is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

Commanding Officer

U.S. Army Ballistic Research Laboratories  
Aberdeen Proving Ground, Md. 21005

13. ABSTRACT

On the night of 18-19 November 1966, seven luminous trails were produced between 85km and 167km by the release of tri-methyl-aluminum from projectiles fired from a smoothbore sixteen-inch gun located at Yuma Proving Ground, Arizona (114.2°W, 32.8°N). Two additional sets of four trails each were produced on the nights of 16-17 November 1966 and 19-20 November 1966. These trails were photographed by cameras located at Yuma and Gila Bend in Arizona and at Blythe, California and have been analyzed to yield wind profiles. This report contains the tabulated wind data for all fifteen trails together with plots versus altitude of wind components, wind speed, and wind heading.

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14.	KEY WORDS	LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT
	HARP High Altitude Research Project Ionospheric Winds						

UNCLASSIFIED

Security Classification